INDUSTRIAL HOUSING

INDUSTRIAL HOUSING

With Discussion of Accompanying Activities; Such as Town Planning—Street Systems—Development of Utility Services—and Related Engineering and Construction Features.

BY

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INTRODUCTION

This book has been the result of a realization, on the part of the author and his associates, of the interdependence of many agencies and the need of the coördination of several professions in the development of a successful town plan and in the up-building of a contented industrial community.

Unusual and unprecedented experiences, as a result of the Great War, followed several interesting earlier opportunities to become acquainted with and take part in various functions of the development of residence sections of towns for housing industrial workers. These ranged from the direction of large and comprehensive projects, providing for many thousands, to studies of smaller mining camps, to replace the heretofore customary groups of ill-assorted shanties. They also covered engagements from the beginning of investigations for determining needs to the fulfillment of a completed program. Thus the need of the budget, to balance requirements against resources, and of a rational plan from beginning to end of the enterprise, impressed itself as an early and ever present necessity.

Certain factors have become outstanding and fostered from time to time, in the development of housing programs.

First—following a belief that something must be done better to provide for workmen during the living hours of the day, attractiveness in houses has frequently been predominant.

Second—pleasant surroundings have apparently loomed large and change from barrenness to blossoms has resulted, while gardens have also become an important feature.

Third—the idea of community recreation, with playgrounds, swimming pools, municipal centers with buildings, meeting places, etc., has been developed, with a sudden realization of the need and desire for community expression.

All of these steps and ideas have been good in themselves, but no one, however complete in itself, fills all the need of community life and spirit, and all too frequently attractiveness and pleasant surroundings have not meant healthfulness and correct sanitation, which are so fundamental to permanent good living. So it has eventually been recognized that not only must the home be well

planned for economy and efficiency, but also the utilities and facilities that go to make up the town and its business and social life.

The author and his organization had the good fortune to participate in the early months of our entrance into the war, in the creation of quarters for troops at one of the National Army cantonments, and one of the National Guard tent camps, built during 1917. Later, being called to assist in the building of towns for the housing of ship workers, it was his good fortune to sit in on the consideration of the plan and scope of the program for this purpose. Both were unique experiences and intensified the belief (if this were necessary) that no one profession is competent to cope with the difficulties of housing.

Gathered together from all parts of the country were men from all walks of life; imbued with the idea of helping to build homes, to attract to ship yards, to build ships, to send the troops and supplies to France, to help win the war. Many had never heard of each other and several only knew of the other's reputation in his chosen line. Most of the recruits were strong individualists, had done things worth while; and many had not, at least for years, worked under the direction of others or in multiple harness. What wonder, then, that it took some time to settle down and get up speed, which later so characterized the work as to win the commendation of the Senate Committee, which was called upon to investigate these activities of the Emergency Fleet Corporation of the United States Shipping Board. The writer would not have missed this opportunity for service, nor this development of new experience, for all of the chapters in his life which had gone before.

He deems it a stroke of good fortune that he had the privilege of associating with the pioneers who were the leaders in the program and who, with all the background of personal accomplishments, sank personality in the common purpose. Early and always there was an appreciation by all that team work, esprit de corps, fitting of endeavors as well as of abilities together, were needed to bring about the result. And the result was achieved. Witness the home-like communities from Maine to the Gulf, along the Atlantic and on the Great Lakes and even on the Pacific, which testify to the wisdom and excellence of the program. It is also a tribute to the far-sightedness of the planning and the personal magnetism of the leaders of the organization.

It is evident that without the team work which actuated and permeated the conference, the committee study and joint departmental action, nothing like the concerted effort could have been put forth. The necessity for the site-and-investigation-committee to consider all phases of the project—social, living, working, topographical and physical conditions, the utility facilities and material possibilities—was but a forerunner of the further coöperation needed by the town planning, architectural, engineering and real estate branches of the Housing Division, in order to develop, in an orderly but at the same time prompt manner, facilities needed to house workers expeditiously.

The author, therefore, with all of this background and with a growing appreciation of the necessity for expanding the program for home building in the future—believing that if the enterprise is not approached in a comprehensive way with large-scale production, it will be utterly inadequate and fail of its purpose—conceived the idea of chronicling some of the conclusions from this experience. In this manner it is hoped they may be available to others who have not had a like opportunity to participate and secure such results.

The endeavor has been to develop the things which must be considered by orderly procedure in providing not merely houses but homes, with all the attendant attributes of a living and livable town. Not all of the features discussed in the following chapters will be applicable to any one place, as the requirements are dependent upon isolation, contiguity to other places and facilities already existent. But all must be considered, so that if it be really unnecessary to provide for any one of them, then the reason will be known. It is certainly apparent that houses alone, however attractive, will never supply a complete town. It is prerequisite to consider these and the whole town in relation to others in the vicinity; also the appropriate planning of streets, blocks and lots; parks and recreation facilities; the utilities, such as drainage, sewerage, water supply, gas and electricity, transit and transportation, health and sanitation. Thus we have the need to consider every feature and to use more than one profession; the need of coördination of all under able leadership is apparent.

While appreciating that engineering and its related activities of construction have a mighty part to play in the expenditure of money and the future cost of the town and its success, and although

the author is a practicing engineer himself, this book is not written solely for the engineer or from his point of view alone; neither is it a treatise on technical practice. It has been written in the realization of a fact now generally acknowledged that, in addition to the architect, who is first thought of because we are thinking in terms of houses and homes, there must be present the town planner, the landscape gardener, the engineer, the sanitarian, the utility designer, the constructor, the realtor, the civicist and the public spirited business representative.

To all of these and to city officials—particularly the City Managers, Directors of Public Works and Municipal Engineers and Architects—this book is dedicated, with an earnest hope that it will appeal as filling a need where no adequate treatise has heretofore existed.

PITTSBURGH, PENNA.,
August, 1920.

MORRIS KNOWLES.

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INDUSTRIAL HOUSING

CHAPTER I

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Origin of Industrial Housing—Examples of Industrial Housing—The Present Problem

ORIGIN OF INDUSTRIAL HOUSING

The housing problem is as old as the human race, for it has its origin in that "first law of nature"—self preservation. Food, shelter and raiment are essential to the satisfaction of this primitive instinct, and ever since the first man sought shelter in his cave, the housing problem has been a vital part of the human life.

Statement of Problem

But the need for shelter is only the origin of the problem. The normal man has other healthy instincts; for work—the chance to express himself in creative activity; for play—the opportunity to re-create himself during the leisure hours when he is free from his employment; for love—and the making of a home in which he can express his affections and his devotion to his wife and in the raising of his children; and for religion—the establishment of a right relation between himself and his Creator. So much of the time of the man and of the members of his family is spent in the home, that the latter reacts upon the satisfaction of all of these instincts, and the housing problem thus becomes the home problem, the problem of surrounding the home with an environment conducive to a full and healthy life.

Moreover, the housing problem is not one of the house alone. Man is a social animal, and early exchanged his normal life for a gathering in settlements, the growth of which has been one of the most marked characteristics of the growth of civilization. The environment of the home, therefore, includes the homes of other human beings, the methods of passing to and from them,

and to and from the working places of their occupants. And so the housing problem has become related to a vast complexity of other problems, all of which must be taken into account in its solution.

The Individualistic Era.—Prior to our present industrial age, the provision of houses, and the determination of whether they and their environment should fulfill the requirements outlined above or not, depended largely upon the intelligence, energy and thrift of the individual. During, and for a long time after the primitive age and the period of serfdom, the family supplied all of its own needs—food, raiment, and shelter. And later, even when specialization began to be well developed, production was carried on in small units. Men were largely capitalists as well as workers, house builders as well as home makers, so that any man of energy and thrift could have the opportunity of exercising a measure of control over his destiny.

The Factory System.—The invention of the steam engine and the development of the factory system, however, completely changed the housing problem, as they likewise altered all the other factors in life. Specialization has been carried to a point where some of our workers spend their working hours repeating, times without number, a single mechanical operation. And out of the wages he receives for devoting his energies to this single function in the supply of the wants of the social organism, he must provide for himself and for his family food, clothing, shelter, recreation and all the needs which once were provided within the family itself, and which must be fulfilled in order to promote a normal family life.

At the same time, specialization applies to all the other elements in production. One man devotes himself to the designing of the machines, which permit the workman, by his thousands of repetitions of a single task, to vastly increase his output. Still another tends the boilers, which supply the force to the machines; a separate group mine the coal to operate the boilers; others supply the skill in management, which co-ordinates the efforts of the workers and still others control and direct the use of capital and credit, which supply the life blood of the whole industrial organism.

Therefore, even though wages were sufficient to meet the legitimate needs of the worker and his family, and even though he should be thrifty enough to save the cost of providing himself

with a home, the factory system and its specialization do not conduce to the development of his initiative and activity along lines so far removed from the job which he knows, as is house building. House design and construction, and the planning of groups of houses have themselves become highly specialized, as have all the building trades and supply lines, as well as the credit and financial machinery in use in connection with such operations. Small wonder, then, that the time has long passed when individual action can hope to maintain a supply of homes equal to the demand, or that the law of supply and demand and the need of specialization should have called into being the real estate operator, the speculative builder, the industrial housing problem, and the necessity of intervention by governments and industries, in order to attempt a solution.

Development of Industrial Housing

The recognition of the existence of this problem came early in the history of the factory system. But, as frequently happens, such recognition was sporadic and partial, and not general and complete. Thus, the problem has grown out of all proportion to remedial measures, and the result has been the unhealthy and anti-social housing conditions in our cities and industrial towns, with which all are familiar; and a description of which is no part of the subject of this book.

Looking back, with the discernment born of experience, it is easy to see the reason for these conditions. The factory system required the concentration of the working population in cities, and those cities have grown by leaps and bounds. Workers have come into the congested areas from rural districts, with habits and standards of living entirely unsuited to the new conditions, and with no realization of the effect of these circumstances upon their health, comfort and efficiency. At the same time, "*laissez-faire*" was the order of the day, and house and town building were left to private greed and unenlightened self-interest; thus our cities grew, without intelligent planning,—a heterogeneous mixture of the good and bad—and with a disregard for consequences which threatened social suicide, through the growth of the congestion and the resulting insanitary surroundings and evil social conditions.

Early Efforts and Improvement.—Three distinct phases can be distinguished in the history of the movement to remedy these

conditions, which may be designated as periods of criticism, study and construction.

The first includes the recognition of the problem, and some attempts clouded by other policies, by such early humanitarians as Robert Owen; and the work of civic and social workers and charitable organizations, in bringing home to the world the importance of the problem, the dangers of the conditions which were developing and the opportunities for social progress through better housing. In this phase, data and opinions were compiled, and much light thrown upon the relation of the housing problem to the individual, to industry and to the state. At the same time, various unrelated and often groping efforts were made to improve conditions, many of them dictated by philanthropy, and a beginning was made in corrective legislation, requiring the abolition of slums.

Study of More Complete Remedies.—In the second phase of the movement, ways and means for solving the problem more completely were studied and discussed, and the industrial housing problem began to be distinguished as a special form of the general housing question. Restrictive legislation—fixing minimum standards for light, air, sanitation and convenience—and the establishment of municipal housing bureaus, to pass on plans and to make inspections, were characteristic of this period.

Various pioneer attempts were made to solve the problem in some of its phases, by the construction of the early industrial towns and mining camps, and by building of mill tenements and company boarding houses in early New England developments. The period was characterized by incorrect social hypotheses and a complete lack of consideration of this all-important aspect of the industrial housing problem. A direct result was too often an academic paternalism, and misdirected charity which produced its most dismal failures in America, where native individualism and independence are directly opposed.

During this stage, progress was facilitated by co-ordination with other movements and influences, such as better sanitary standards and practice, and the development of the town planning idea. A powerful influence has been directed upon the movement for better housing by the development of public health, sanitary science and engineering, and of the art of town planning.

The discovery of the germ theory of disease made possible the exact definition of the dangers of conditions which had long been condemned as evil. It also permitted the formulation, in exact terms, of the requirements of health with respect to light, air, cleanliness, quality of water supply, disposition of human wastes, etc. At the same time, the relation of the arrangement of lots, blocks and streets to health, convenience and amenity, and the possibilities of attractive as well as practical town layouts have become so clearly demonstrated that it is no longer possible to separate the housing problem from that of city and regional planning.

A third tendency, which has had powerful influence upon the development of the industrial housing problem, has been the movement of some of our largest industries out of existing cities into suburban or self-contained towns, created for the purpose of housing the labor supply. Graham R. Taylor[1] has well expressed this movement as the resultant of centrifugal and centripetal forces of cheap land, low taxes and room for growth, pushing industry out of the congested city area; and railroad facilities and proximity to markets and labor supply, holding industry in the neighborhood of urban centers.

The effect of this last tendency has been to open up an entire, new field of opportunity in designing industrial villages, down to the last detail; thus they may best serve the needs of the human elements, and of the industry through which these latter make their economic contribution to society.

Construction and Prevention.—The present stage of the movement for better housing may be described as one of preventive, constructive and economic activity. The value of the proverbial ounce of prevention has been recognized and the criticism of existing conditions is being combined with the results of academic studies and with the practical lessons learned from pioneer attempts at improvement. On this basis, the solution of the industrial housing problem is being sought in the co-ordination of the industrial, civic, municipal, state and national agencies, so as to bring about the construction of sanitary and attractive homes, grouped in convenient and healthful towns, under conditions which will permit the workingman to rent or buy a home within the limits of his resources.

[1] "Satellite Cities," 1915.

EXAMPLES OF INDUSTRIAL HOUSING

Before the War

The earliest examples of industrial housing were of two types, the mill tenements and boarding houses, and the mining "camps."

Mill Tenements.—The first textile mills were established in towns, where a labor supply existed and could be drawn upon. As congestion led to bad conditions, men like Robert Owen, at New Lanark in Scotland, and Francis Cabot Lowell, in Massachusetts, endeavored to improve conditions by constructing "model" mill tenements and boarding houses; "model," that is, for those days, about the beginning of the nineteenth century. They would not compare favorably with one of our modern industrial villages. Thus these earliest examples were primarily philanthropic in origin.

Mining Camps.—The mining industry, however, differs from others in that it usually is carried on in isolated, uninhabited localities where, just as on construction jobs, some type of shelter for the labor force must necessarily be provided. Under these conditions, and without the ideals that were back of the first mill tenements, the first mining villages (and many of the later ones) grew up as garish groups of shanties, without adequate sanitary facilities; and absolutely devoid of comfort, attractiveness and opportunity for recreation. Such villages have been deservedly called "camps" and "patches," and whether they have existed at mines or factories, they have done incalculable damage to the spirit of American industrial labor.

Early Industrial Towns.—During the latter part of the nineteenth century, and at the beginning of the twentieth, industrial concentration and the movement of factories to the suburbs had progressed far enough, so that industrial housing experiments began to appear on a more important scale than the early mill villages and mining camps.

Pullman, constructed between 1880 and 1885, and Gary, started about 1906, are typical as well as two of the most important examples. In each case, a great industrial corporation created, out of undeveloped nature, a complete city, where vacant fields had been before. And in each case failure to solve the human problem and to promote sound conditions resulted at Pullman, because of the unwise paternalism of the company's

attitude toward its employees; and at Gary because there was left to exploiting speculators the most difficult part of the problem, the housing of the unskilled worker, and because nothing adequate was done to relieve the monotony of the Indiana sand dunes.

Other equally effective examples could readily be cited, but as the object of this review is to trace the history of the development of the industrial housing problem and its solution and not to catalogue the experiments that have been tried, these typical examples will serve the purpose.

The Garden City Movement.—During the period when these early experiments were being tried, the garden city movement in England and on the continent was gaining headway; and began to make its influence felt in America. Such attractive developments as Hampstead, Bounville, Harbourne and Letchworth were widely pictured to our industrial companies and town planners as models. Impetus was thus given to the idea of planning industrial villages in their entirety, and to the accentuation of attractiveness as an element in prompting healthy life and a productive industrial spirit.

At the same time, the example of Port Sunlight strengthened the recognition that paternalism could not succeed in democratic America. The organization and growth of Co-partnership Tenants Limited, in England, however, brought out in a suggestive way the possibility of making use of cooperative methods of organization.

Newer Industrial Towns.—Under the influence of all these examples and forces, the early mistakes were followed, in the early part of the twentieth century, by other towns which showed progressive growth toward higher and better ideals in industrial housing. The United States Steel Corporation has built at Fairfield, Alabama, a town which still stands as an example, in many ways, of the attractive possibilities of town building under centralized control and intelligent planning. Later, at Morgan Park, Minnesota, the same corporation built an equally attractive development, and at the beginning of the Great War plans had been completed for a steel city at Ojibway, Ontario, (not yet built). All of these represent the best efforts of some of the best trained town planners, engineers and architects in the country, and give promise of results which will go far toward the solution of the housing problem.

The work of this greatest of industrial corporations has been more important, and has resulted in the development of a more comprehensive program than that of any other company. But many others have taken part in the movement, and before the War there were already many attractive developments, located in all sections of the country. Complete lists will be found in the bibliography in the Appendix, but the later developments of some of the villages of the New England textile mills and of the Ohio rubber industries are particularly notable.

Effect of the Great War

No field of human endeavor escaped the profound effect of the great cataclysm of the Great War, and the industrial housing movement was entirely altered and made over by it.

Cantonment Construction.—The most pressing housing need, upon our entrance into the War, was the provision of shelter for the millions who were to be called to the colors during their period of training. The construction of the National Army cantonments and the National Guard camps resulted; the greatest building construction program ever undertaken.

While the work of the Construction Division of the Army cannot properly be considered as a part of the industrial housing movement, nevertheless, it could not fail to exercise an important influence upon the latter. For it gave us, a new experience in comprehensive planning and organization, and demonstrated anew the fundamental character and advantage of large scale production and many of the principles upon which the modern art of housing and town planning are founded.

Governmental Housing.—The most direct influence of the War upon industrial housing, however, grows out of the house and town construction undertaken by the Government itself. Equally important with the training of our soldiers was re-organization of our industries, so as to increase vastly the production of those things which are most needed for the supply of troops in modern warfare.

The effect of this imperative necessity was deep seated. Workmen had to be concentrated in the vicinity of mills and factories and shipyards, and removed from sections where they were established in less essential industries. Huge additions had to be built to existing and new plants, and shipyards were

thrown up over night in new localities, many of them of a size to stagger the imagination. The distribution of materials of all kinds, and the control of transportation had to be taken over by the central Government, in order to make possible the carrying out of this stupendous program.

Under these circumstances, the ordinary machinery for supplying dwellings for workingmen and their families, through private initiative and through the activity of industrial corporations, could not but break down. The Government, therefore, was compelled to undertake house and town construction in order to provide for this unprecedented shift in population.

The United States Housing Corporation and the Housing Division of the Emergency Fleet Corporation were the result. The former planned 128 towns or groups, an estimated cost of which was $112,000,000, which contained 19,100 dwellings, sufficient to house a total of 21,000 families. The latter made a total expenditure of about $71,000,000 and built 27 towns, containing 8,841 houses, with a total capacity of 9,493 families.

Mistakes were made, of course, by both organizations, as mistakes were made by every agency which worked under the pressure of the conditions created by the Great War, and costs were greater than they would have been in construction carried out under more normal conditions. But in general, the work of the United States Housing Corporation and the Emergency Fleet Corporation cannot fail to have a lasting and beneficial effect upon industrial housing in America. For, taking advantage of the experience to which reference has been made above, both of these services called to their aid skilled architects, engineers, town planners, landscape developers, realtors and members of all the other professions, whose work is involved in industrial housing. The result has been that these developments, scattered throughout the country, have set standards for comparison which will doom to failure any less carefully planned housing project in the future.

The House Famine.—However, it is not only by these instructive experiences that the War has affected industrial housing. The Government program was only just begun when the Armistice was signed, and only a fraction of it was carried to completion. However, even if it had been entirely completed, there would still have been a shortage of homes. As it is, the famine has spread to every city and town in the land, and it is estimated

that there is a deficiency below actual needs of about 2,000,000 homes in the country today.

The causes of this situation are evident. First, the shifting of population, incident to the industrial reorganization during the War, was only partly temporary. Our shipyards are continuing to build for our New Merchant Marine, and many munitions plants have been converted into peace-time industrial plants. A permanent increase in the population of our industrial cities has therefore resulted.

At the same time, the construction of dwellings, even including the Government construction, far from being sufficient to meet this abnormal increase in demand, did not even keep pace with the normal, peace-time increase in requirements, and in fact, for three years, was practically at a standstill.

A serious deficit therefore exists, as is evidenced by the distress of home-seekers in all parts of the country, by the countless industries being forced into the housing field, and by the numerous "housing corporations" being organized all over the land.

Construction Costs.—A further effect of the War, and the financial upheaval accompanying it, has been the great increase of construction costs above all previous levels. The inflation of currency and the expansion of credit, together with other influences affecting the supply of and the demand for goods and labor, have decreased the purchasing power of the dollar to a fraction of that before the War. Prices have thus risen to a point that has practically destroyed the usefulness of all past experience in construction costs, and that has introduced an element of uncertainty which tends to retard all influences looking to the restoration of normal supply of dwelling houses.

At the same time, the lag which always accompanies changes in price levels, and the unwillingness of tenants to pay increased rents, coupled with the readiness to single out the landlord who increases rents as a "profiteer," have combined to destroy the incentive to private builders to build, while making financially more difficult the carrying out of housing programs by industries and housing corporations.

Governmental Aid.—The breakdown of the usual economic machinery for securing the construction of houses had led to an increasing pressure on Governments, both here and abroad to subsidize house construction by tax exemption, by loans at low

rates of interest, and in other ways. In this country, "home loan bank" legislation has been introduced and strongly urged upon Congress. Both in Great Britain and in Canada, funds have been provided and loans for the construction of low priced houses have been authorized.

THE PRESENT PROBLEM

At the present time, therefore, the industrial housing problem promises to reach its full development. A general, acute shortage of homes, and the price situation, have made impossible the solution of the problem by individual action, and have made large scale house production by specialized agents, not only desirable, but absolutely necessary.

Logic of experience has evinced the value to industry of a supply of homes not only sufficient in quantity but satisfactory in quality. The beneficent effect thereof on the stability, contentment and loyalty of labor is well known.

In solving these problems, the incomes, habits and desires of the employees; the requirements of the industry and the interests of the community and the state all must be taken into account. · Subsidy by industry, philanthropy, or by the Government may possibly be helpful agencies, but in any case industry is so vitally interested, it must achieve some successful solution in order to attract and keep suitable labor. The numerous experiments that have been made, and the experience during the War, have demonstrated that in order to fulfill these requirements, full consideration must be given to the health, comfort, convenience and amenity, and finances of the prospective occupants.

The present day problem of industrial housing, therefore, is to organize the necessary professional services,—together with the employer, the employee, the municipality, the state and the nation; so as to secure the construction of homes for our workmen, of such kind, in such surroundings and on such terms as will promote their loyalty, and as will cultivate an industrial spirit that will lead to the increased production which is the greatest need of our country and of the world.

CHAPTER II

FUNDAMENTAL PRELIMINARY CONSIDERATIONS

ADVANTAGES OF MODERN INDUSTRIAL HOUSING—COST OF MODERN INDUSTRIAL TOWNS—MARGINAL DEFICIT OR NECESSITY FOR SUBSIDY—PROCEDURE OF ORGANIZATION AND FINANCE—TECHNICAL PROGRAM

Introduction.—The industrial housing question may be considered to have two phases; one in connection with urban industries and one for rural industries. By far the greatest number of industries have been established in existing communities and the housing of workmen in such circumstances has followed channels which have been largely undirected and uncontrolled by the promoters of the industry.

Frequently, in connection with modern plants, correct lighting, ventilation and sanitary facilities have been installed, in order to maintain efficiency and health among the workers. Thus working conditions within the plants have improved constantly and steadily, while housing conditions of the families in the adjoining communities have been forgotten and too frequently have grown steadily worse. Private enterprise and personal effort have failed to create wholesome or adequate homes and living conditions for workers and their families; large concerns, therefore, now generally realize that the housing of employees must be considered a problem of industrial development. It cannot be evaded or solved by merely establishing the industry within an existent community. It is incumbent upon the management to see that satisfactory homes are available for the workmen, if not by independent agencies, then by the assistance or initiative of industrial executives.

In the second classification, the industry is to be situated in a rural or isolated section and hence demands the creation of a new community with all of its multifarious details. It has some of the elements of the foregoing situation but in many features is peculiar to itself.

Certain industries for years have housed their workmen in isolated "company towns." In many cases these towns have consisted of a garish group of houses, without adequate sanitary, recreational or livable facilities. They have frequently and deservedly been called "camps." To infuse the vital breath of life; to convert patches of houses into a community of homes; to make the camp a town; this is the second phase of the industrial housing problem.

ADVANTAGES OF MODERN INDUSTRIAL HOUSING

Does It Pay.—No new enterprise will merit favorable recognition until the eminently practical and sensible question—does it pay?—is given consideration. What are the costs of and what are the returns on modern industrial housing?

Unfortunately, like many influences dealing with human beings, the returns from wholesome housing cannot be accurately expressed in dollars and cents. The stresses and strains of human nature follow no exact law, as do those in concrete and steel. Because returns are immeasurable, however, does not indicate that they are not real. Favorable influences and reactions resulting from good housing are easily discerned by those who seek them.

Many a community may at first wonder why, according to the Fourteenth Census, it takes a place lower in the rank of populations than formerly accorded to it. As a result there may possibly be a more general realization of the discriminating elimination by labor of such places as do not provide comfortable and convenient homes, pleasant surroundings, adequate transportation, potable water, and educational and recreative facilities, and why labor, therefore avoids unsatisfactory living conditions, insofar as possible. This reaction of labor to environment is none the less real because it may be only vaguely felt rather than consciously reasoned.

Plant and Town Compared.—An illustration of the need of wholesome living conditions may be exhibited by a comparison of the number of hours spent in the plant by the workers, with the number of hours spent in the community by the family. Assuming an eight-hour working day and 300 working days per year, it can be computed that the industrial worker is in the plant only 27.4 per cent. of his time. Moreover, if in the average

family of five, we assume that 1½ members are engaged at the plant, it is seen that only 8.2 per cent. of the entire family's time is spent in the plant. The remainder, or 91.8 per cent., is spent under influences considered under the subject of "Industrial Housing."

To the average man the most interesting and important consideration in life is himself and his immediate family. He works for a wage simply that he may be enabled to obtain the necessities of existence and enjoy the pleasures of life. The wage itself is merely the medium in the barter. It is true that while the workman derives his all important livelihood while at the plant, the expenditure of this income on house rent, food, clothes and recreation is directly affected by townsite conditions. And surely the conditions under which the income is expended to obtain the necessities and pleasures that are demanded should be as carefully considered as are those under which the pay is obtained. While the plant is the mean of livelihood, the home and the town are the tangible means of expressing life; whatever improves living conditions reacts upon the individual as potently as do improved working surroundings. Labor unrest is not due entirely to lack of sufficient pay, but in many cases to the psychological effect of the laborer's family upon himself, due to poor living conditions.

Labor Turnover.—Wholesome living conditions have generally been highly effective as an aid in preventing or reducing labor turnover, with its enormous costs. The recent experiences of our war industries convincingly proved that unsatisfactory and inadequate housing was one of the principal causes of the enormous labor turnover, which in the early stages of the work, so interfered with their productive efficiency. Even unusually high wages failed to hold the workers, and as a consequence the United States Government was forced to appropriate $190,000,000 to provide good houses for the workers.

Alexander, in 1913, found no fewer than five distinct elements of cost in hiring and training new employees. These were:—clerical work in connection with the hiring process; instruction of new employees by foremen and assistants; increased wear and tear of machinery and tools by new employees; reduced rate of production during early period of employment; increased amount of spoiled work by new employees.

The same investigator studied twelve factories, where 42,500 new employees were hired in one year, and estimated that the cost of hiring a new man was between $35.00 and $40.00.

Greaves, in 1914, made a study of twenty factories, where 69,000 new employees were hired to maintain a force of 44,000. He estimated the cost of hiring to be $40.00 per man employed.

In 1918, the cost of breaking in a new employee was estimated to be from $75 to $150, by the General Motors Company.

The Ford Company, from October, 1912, to October, 1913, had a turnover of 416 per cent., and the yearly cost of this turnover was said to be over $2,000,000.

During 1916, a rubber company in Ohio, employing 16,000 men, found that it had a turnover of 30,000 men. It was found that 85 per cent. of these were single men, between 21 and 30 years of age, and mostly Americans.

If the same position must be refilled three times in one year—not an unusual turnover—at the cost of say $240 per year, these changes would constitute a loss that would pay the interest on an investment of $4,000, a sum which would go far toward supplying a satisfactory house.

Regulated Payrolls.—A modern industrial town, planned in proper relation with the plant, permits a conscious control over the selection of the classes of employees, impossible of attainment when the town is not "built to order." Industrial managers and foremen know only too well that the percentage of married to single men carried on the payroll is often affected by the casual availability of rooms or houses in the neighborhood. The correct percentage can be maintained by providing the right proportion of houses and rooms.

Likewise the percentage of skilled to unskilled workers; the percentage of foreign to native workers, the number of women workers and minors can be regulated to produce maximum efficiency, by building the town to suit the plant. The modern industrial town has all the advantages of the home built to one's taste, as compared with the house purchased ready built. This advantage is strikingly shown by an example given in Chapter X, where the method of computing the number and types of houses and rooms is discussed.

Loyalty and Efficiency.—The value of long service on the part of employees is only partly represented by the figures on the cost of labor turnover. The skill, experience, certainty and loy-

alty that accompany long steady service are of inestimable value to the industry.

The contentment that results from wholesome living conditions goes far toward producing plant efficiency, and in promoting that esprit de corps which is so indispensable to any properly functioning organization. No matter how well organized the industry or how modern the equipment, successful operation depends largely on the attitude of mind of the invididual worker. An ounce of loyalty is worth a ton of time clocks.

Bad living conditions have their greatest effect on the workman's family; but the discontent, ill health, and irritability of his family surely react upon the wage earner himself, who generally thus becomes thoroughly infected with dissatisfaction, and frequently resentful at the entire environment which caused it, and no workman in such a frame of mind can really be an effective producer or an harmonious part of the organization. Many a disagreement culminating at the plant had its origin and nurture in the unsatisfactory living conditions outside of the plant.

Health.—Clean and comfortable living quarters unquestionably conserve the health of the worker. Pure water, efficient sewerage, means for maintaining clean streets and premises, and hygienic houses are essential. A cheerful, healthy, virile and efficient community will not develop out of the filth and disease of an insanitary environment.

Modern Practice and Aims.—Aside from the above elements, what more practical evidence is needed than the fact that our largest and most successful business concerns are investing large sums of money in modern industrial housing; though the return on such invested capital cannot be segregated and expressed in dollars and cents.

Big business has given birth to big conceptions as to the purpose and province of large industrial enterprises. Its service concept, as well as its role as an instrument of profit, is now recognized as a worth-while motive for large corporate undertakings.

COST OF MODERN INDUSTRIAL TOWNS

Elements Considered.—Though the returns on good housing are indefinite, the estimated investment can be expressed in dollars and cents. Every industrial executive should know the

approximate outlay required to gauge intelligently the wisdom of the expenditure.

A modern industrial townsite is more than a group of houses; it is a vital, breathing community of homes. The physical elements contributing to such a community are the land; the houses; the buildings other than houses, as quarters for single men, schools, stores, clubs, churches, etc.; the utilities, such as water supply, sewerage, drainage, gas, electrical and transportation systems; the street improvements; and, finally, the parks, playgrounds and reservations.

Figures relative to the cost of these various items are of limited value without full information concerning the given project. To afford an approximate conception, however, estimates for several modern towns are given in the following pages.

Hypothetical Example.—The author recently (1920) computed the cost of an hypothetical town in which the following conditions were assumed:

A site of approximately 130 acres, with flat topography, in the vicinity of but not immediately adjacent to a city: 1000 detached houses, 22 ft. wide and 26 ft. deep; lots, 42 ft. front by 100 ft. deep, with 15 ft. of set-back. Main streets, 50 ft. wide, improved with 26 ft. wide, water-bound, macadam roadway, with concrete curbs, a 6-ft. planting strip, and a 4½-ft. concrete sidewalk on each side of the street. Minor streets, 40 ft. wide, with 18-ft., water-bound, macadam roadway, furnished with concrete curbs, 5½-ft. planting strip and a 4-ft. concrete sidewalk on each side of the street. Gridiron street systems, with no alleys. Length of each block, 588 ft., width 200 ft., with 28 houses in each block.

A filtration plant and pumping station were assumed, two miles distant from the townsite; a sewage disposal plant located one mile away; an electric transmission line two miles long, and a gas trunk feeder one and one-half miles long, each considered to derive its supply from an existing plant.

With this assumed town site and using unit prices current in January, 1920, the following relative costs of house and improvements per house were computed. The cost of land was arbitrarily fixed at 2½ cents per sq. ft.; and the house itself, suitable for a semi-unskilled worker, was assumed to be built for $3,500.

The itemized estimates of cost are presented int he following table, together with the percentage cost of each item.

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TABLE 1.—ESTIMATED COST OF IMPROVED HOUSE AND LOT IN AN HYPOTHETICAL TOWN

Nos.	Items	Cost per house and lot	Per cent. of total cost	Per cent. including overhead
1.	House (average cost)	$3,500.00	63.4	73.7
2.	Land in lot	105.00	1.9	2.2
3.	Land in streets	35.18	0.6	0.7
4.	Lot improvements	264.71	4.7	5.6
5.	Street improvements	308.27	5.6	6.5
6.	Water supply and distribution	149.44	2.7	3.2
7.	Electrical lines and lighting	19.31	0.3	0.4
8.	Gas supply and distribution	74.67	1.3	1.6
9.	Sewers (storm and sanitary)	162.96	3.0	3.5
10.	House connections	125.60	2.2	2.6
		$4,745.14		
11.	Supervision and engineering, @ 10 per cent	474.51	8.6	
12.	Interest during construction, @ 6 per cent	313.18	5.7	
		$5,532.83	100.0	100.0

Summarizing the foregoing, it will be noted that the house is 78.5 per cent. of the total cost, including a distribution of overhead; land with lot improvements is 8.3 per cent.; street improvements, with land for these, are 7.7 per cent.; water, electrical, gas and sewer improvements with house connections constitute 11.5 per cent.; engineering, supervision and interest charges, which are distributed in these statements, are 14.3 per cent. of the whole.

The foregoing estimated total cost of $5,532.83 is to be considered the gross cost of land and all improvements. The net cost will depend on local conditions and may be arrived at, by deducting from the gross, such costs as are borne by public utility companies and paid for in rates or assumed by municipalities and paid for by them out of general taxation. Local custom is this regard differs; generally public utility companies are required to extend service, providing the return warrants; municipalities frequently pay for the entire water supply and distribution s stem, for sewer outfalls, approximately ten per cent. of sewer and storm drains; from 10 to 15 per cent. of cost of pavements, and the entire cost of sewage disposal plants.

Another Example.—The author, during 1919, planned a new-semi-industrial town in Eastern Pennsylvania. The site, with slightly sloping topography, contained 100 acres, and was divided into 263 lots and four industrial sites. The principal streets were 50 ft. wide; minor streets, 40 ft. wide. The lots varied in width from 40 to 50 ft., with an average depth of 150 ft.; average area of lots about 9,000 sq. ft. The lengths of the blocks were about 600 ft. Alleys were omitted. Electrical and gas utilities were not included.

TABLE 2.—COST OF HOUSE, LAND AND UTILITIES
(Number designation is the same as in Table 1).

Nos. Items	Basis of estimate	Cost per house and lot	Per cent. of total cost
1. House	Average for medium paid workers	$4,000	70.0
2. Land	Based on cost plus carrying charges for three years; no improvements	90	1.6
5. Street grading	Based on cost of excavation and filling to sub-grade	90	1.6
5. Street paving	Based on tar-bound macadam	210	3.7
5. Sidewalks	Based on concrete walk 4½ feet average width, on both sides of street	100	1.7
6. Water works	Based on wells, pumping station, elevated steel storage tank, and 4, 6 and 8-inch cast iron pipe distribution system	170	3.0
9. Sanitary sewer system	Based on 8-inch tile pipe, at depth of 9 feet, with manholes, and sewage disposal works	150	2.6
9. Storm sewers	Based on 15-inch tile pipe, with 3 feet cover, discharge at edge of town	60	1.1
	Sub-total	$4,870	
11.	Supervision and engineering, @ 10 per cent	487	8.6
	Sub-total	$5,357	
12	Interest during construction, @ 6 per cent	321	5.7
	Total	$5,768	100.00

Average of U. S. Housing Corporation.—The following table presents a summary of the estimated costs per family for 97 housing projects planned by the United States Housing Corporation during 1917-1918. Only 22 of these were built. These 97 projects included accommodations for 21,005 families, and were situated all over the United States, most of these being east of the Mississippi River. As a general rule, the houses were designed for the higher paid skilled workers. The layouts include detached, semi-detached, terrace or row, and apartment houses.

TABLE 3. COST OF HOUSING PER FAMILY AVERAGE 97 PROJECTS—U. S. HOUSING CORPORATION

(Number Designation same as used in Table 1. Based on Assumed Unit Costs)

Nos.	Items	Cost per family	Per cent. of total cost
1	House	$4,374.70	81.0
1-*a*	Other buildings	185.85	3.4
2 & 3	Land	192.14	3.6
4	Lot improvements	147.80	2.8
5 & 10	General improvements	497.62	9.2
	Total	$5,398.11	100.0

(The above figures were obtained from Page 434, Vol. 2, of the Report of the United States Housing Corporation published June 21, 1919.)

Lorain, Emergency Fleet Corporation.—A typical example of the industrial housing developments built by the Emergency Fleet Corporation, Division of Passenger Transportation and Housing, is given in the following table, which presents the approximate itemized cost of the village of the American Shipbuilding Company, completed in 1919 at Lorain, Ohio.

The total area of the project was 43.8 acres; it contained 133 detached houses, 44 semi-detached houses, 2 apartment houses and 2 stores. All were of frame construction. While the village was built within the municipal limits of the City of Lorain, it included a complete layout of streets, all lateral and distributing utility lines, but no feeders, trunks or main transmission lines.

TABLE 4.—APPROXIMATE GROSS COST OF HOUSING PER FAMILY—AMERICAN SHIPBUILDING COMPANY, LORAIN, OHIO.

Nos.	Items	Cost per family	Per cent. of total cost
1	House	$6,560	81.0
2–3	Land	291	3.6
5	Street improvements	505	6.2
6	Water supply and distribution	238	2.9
9	Sewers (sanitary and storm)	204	2.5
4–7–8	General improvements	313	3.8
	Total	$8,111[1]	100.0

[1] The net cost is somewhat less, owing to payment by the municipality for its normal share of municipal improvements.

MARGINAL DEFICIT OR NECESSITY FOR SUBSIDY

Statement of Requirements.—A consideration of elements affecting the cost of a modern industrial town at once presents the concrete question—What constitutes a house? The materials of construction; the number and size of the rooms; the number of families under one roof and finally the extent of the improvements and conveniences provided to guarantee health and comfort; all of these affect the cost.

In Chapter X there are given various views upon the features and requirements of a satisfactory house, expressed by men who have devoted much time and thought to the subject. It is perhaps only natural that there should be a wide divergence of opinion upon such a topic, since, in common with most other typically human questions, it is incapable of exact computation.

However, no doubt all will agree that the house should be such as to conserve the health, safety and welfare of its occupants. The features making for the two former objects are distinctively technical, capable of more or less exact analysis in the present state of the art, and therefore are relatively easy of specification. It is concerning the question of welfare that the greatest difference of opinion occurs. Included in such desideratum are the more obscure factors in home production, such as attractiveness, amenities, comfort, provision for amusement and helpful social intercourse, and constructive or preventative measures, both in house construction and in town building, making for better moral standards of living. While the weight given to these

various items will no doubt depend upon the comprehension or bias of the judge, such have, at least to a reasonable degree, a direct bearing upon health, and consequently may be considered in the class of the necessities.

It is a comparatively simple task to talk about *what should* and *what should not* be considered essential and desirable features of a workman's house. A more difficult task is to devise ways and means whereby these features may be obtained and still keep the house within the rent and purchase price that can be afforded by the occupant. Before reaching any final conclusions on the necessary and desirable features of a workman's house, one should investigate, as a basic starting point, the question—What can the workman afford to pay for rent?—assuming that it is necessary for the house with its improvements to yield a reasonable return on the investment.

Income Available for Rent.—The United States Department of Labor made investigations on the cost of living in the United States, from July 31, 1918, to February 28, 1919, and reported these results in detail in the Monthly Labor Review, for the months of May, June and July, 1919, in Volumes 7, 8 and 9. Nearly thirteen thousand family schedules were obtained in 92 localities, in the different geographical sections of the country, for family incomes ranging from less than $900.00 to $2,100.00 and more. The information thus secured was by personal interview, and in many instances by a review of daily expense accounts, which many housewives were prevailed upon to keep over a period of not less than five weeks. The expenditures were subdivided into—food; clothing; rent; fuel and light; furniture; miscellaneous expenditures and surplus.

The following table, showing only the percentage of income spent on rent, was prepared from the statistics given in the reports mentioned above.

TABLE 5.—PER CENT. OF INCOME SPENT ON RENT (1918–1919) FROM MONTHLY LABOR REVIEW—VOLUMES 7, 8 AND 9.

Annual income	Under $900	$900 to $1,200	$1,200 to $1,500	$1,500 to $1,800	$1,800 to $2,100	$2,100 and over
Per cent. spent on rent..	19.64	13.65	13.12	12.64	12.52	10.36
Number of families investigated..........	488	2769	4152	2751	1622	1062

The average percentage of income paid out as rent was 13.65 per cent., while 75 per cent. of the average family income was from the earnings of the principal breadwinner. Therefore, to obtain the approximate percentage of the principal breadwinner's wage that may be available for rent, the figure directly connected with the wage scale of the industry should be 18.2 per cent.

Certain large industries have found by actual experience that when houses are sold to the workers, a larger proportion of the wage income is available for the purchase of the house than for the rental of the house. This excess is created no doubt by the extra frugality stimulated by the desire for home ownership. One large industry recently developed its housing project on the basis that 17 per cent. of the worker's wages would be available for houses designed for rental purposes, whereas 25 per cent. could be depended upon for those houses which were to be sold. For general purposes, however, 20 per cent. of the wage income is a fair figure to use in estimating the amount of wage available for rent.

With the percentage of wage available for rent, and knowing the wage rate, the amount of money that can be invested in a house and appurtenances that could be self-financed is readily computed. It immediately becomes apparent that for the lowest priced wage earner this amount is insufficient to build a satisfactory house with the present day cost of land, building materials and labor. A marginal deficit exists.

At this point we are brought face to face with the most difficult feature of the industrial housing problem. Stripping it of its non-essentials, the problem is exemplified by the following three financial statements:

1. With its minimum requirements, a detached five-room, modern house, with proper yard room and air space and with all appurtenances, cannot be built in most parts of the United States to-day for less than $5,000.
2. With a 10 per cent. return on the investment for capital cost, maintenance and depreciaton, this house must rent for $42.00 per month.
3. With 20 per cent. of the worker's wages devoted to rent, this would require a wage of $210 per month, or about $8.40 per day for an unskilled worker.

Means to Meet Deficit.—The resources to meet the situation are:

1. To increase the wages or income of the family.
2. To subsidize the cost of the house, either in capital account, or by accepting less than the legal rate of interest in return.
3. To reduce the cost of the house by quantity production, by grouping and by intensified development, such as the use of row houses or other type of multiple family dwellings.

All three are questions of inter-related expenditures. The first two are matters of company policy and bookkeeping. The last is a question of judicious town building, savings in which can be achieved only by the careful, experienced, economical consideration of the design, construction and maintenance of the industrial town.

It should clearly be understood that the foregoing is based on renting a detached house to the lower paid wage earners. If a selling plan is adopted, then about 25 per cent. of the worker's income may safely be assumed to be available for reduction of principle, interest and ordinary maintenance of the house. In this case, the proposed five-room, minimum house could be purchased by a breadwinner, making about $6.50 per day. Important progress toward a solution of the difficulty may be gained by the use of row or terrace houses, duplex and other multiple family dwellings, or of the older, partly depreciated houses which have been vacated by a more productive worker; upon the basis that the needs of the minimum wage earning class may be satisfied by the minimum space allotments dictated by sanitation and hygiene. Such dwellings, although requiring a high order of designing skill, not only reduce building costs, but conserve land and lessen the cost of utilties per family unit.

The gravity of the financial problem presented by industrial housing has caused it to assume transcendent importance in the program of industrial developments. Once considered a side issue, it is now in the fore-front of the important questions, moulding the policies and procedures of industrial expansion. The new attitude, essential to an economical procedure and now fully realized, allows town builders wider latitude and affords greater opportunities for successfully solving the problem than ever before. Often decided advantages may be obtained for the town with no consequent disadvantage to the plant, if final policies regarding the plant location are formulated only after townsite possibilities are carefully investigated and considered.

PROCEDURE OF ORGANIZATION AND FINANCE

Policy as to Home Ownership.— The policy of ownership and town control is one of the most far-reaching considerations which must be faced in the development of a modern industrial town, affecting as it does the entire scheme of financing, the selection of the site, the design of the houses, the order of the construction program, and the administration of the town. Three distinct systems are practised in industrial towns, the third being a compromise of the other two.

In one a company, either the manufacturing concern or a special charter organization subsidiary thereto, maintains exclusive ownership of the houses and improvements.

In the second, the ownership of the houses passes into the possession of the workers, with or without the financial assistance of the company by some cooperative sales arrangement.

In the third system the houses are owned cooperatively by the tenant and landlord through the medium of a co-partnership, or, more commonly, a corporation.

Company-owned Houses.—This is distinctively a renting arrangement. Under it, the houses are financed, built, owned, maintained and operated wholly by the company, and out of appropriations from company funds, together with such assistance as can be gained from the rentals. Ordinarily, where a large amount of unskilled labor is involved, the development cannot be financed entirely from these rentals.

Taxes,—and if the housing development be a separate community, the entire scheme of operation, including policing, health regulations, lighting, fire protection, etc.—must remain the burden of the company. In order to escape some of these responsibilities, as well as in order to conform to a more democratic government, it has been customary to incorporate such company towns and to administer operation by a regularly constituted public government.

In this system the selection of the type or sites and the development thereof, is not affected materially by the saleability of the houses. Materials of construction and general design of the house should be such as to reduce maintenance and operation costs, plus the fixed charges, to a minimum. The irresponsibility of tenants affects the character of interior finish and fixtures. The changeability of tenants calls for designs and improvements acceptable to general, rather than to individual tastes.

The organization can control directly the designs and stages of construction throughout the development, utilizing therefore an efficient town building organization, whereby all the advantages of quantity and standardized production methods may be realized. The system affords freedom and easy mobility to the workers.

Privately Owned Houses.—By this sytem, while the company or an entirely separate corporation bears the financial burden of initiating the project, it is eventually reimbursed by the sale price of the house paid in installments extending over a period of years. The maintenance, taxes, and assessments become the burden of the owner upon receiving title to the property.

The selection of site in connection with this class of house ownership is affected by the saleability of houses. More money as a rule can be invested in the single houses under this system, as the buyers will devote a higher percentage of their wages to the purchase of a house than to the rental of one. Individual, rather than group tastes must be catered to, in order to improve the selling value, a requirement which generally results in a more liveable home. The prospective purchaser is generally allowed some latitude in choice of location, and in the choice of one from among several standard types and sizes of house. Some organizations permit the purchaser to select an original design for his house. Occasionally the lot is simply purchased from the company and the purchaser employs his own architect and contractor. Either of these latter two methods of operation tends to reduce the savings which results from standardization and quantity production methods.

The development of the townsite may be placed in the hands of an independent realty company or privately formed housing company. In this case certain restrictions should be enforced to prevent building speculation which will work a hardship upon the workers. This plan has the distinctive advantage of avoiding paternalism, with all of its attendant evils. It removes a large share of the expense and burden of overhead from the company, and, by reason of its democratic and fundamentally sound economics, has a tonic effect upon the entire community which it fosters.

Where a company assumes the dual role of employer and of landlord or real estate agent, it has generally been found that the worker, unable or unwilling to give fine discrimination, takes

advantage of the rather complex situation, by balancing grievances as an employee against demands as a purchaser or tenant (or vice versa) and will thus insist on far more than his just due. Indeed, there are numerous instances where the company has had to maintain and repair houses for years after they have been sold and paid for. No matter what good intentions both parties have, differences frequently arise in the process of building or paying for the house which, with company control, may cause a permanently discontented worker.

The construction program, in connection with a non-company owned townsite, however, may and often does follow the same course as with company controlled towns, the sales policy being initiated at the completion of the first house.

Coöperatively Owned Houses.—Coöperative house ownership is the result of an endeavor to solve the housing problem, avoid landlordism and paternalism and share the burdens and benefits of a house renting business by providing service-at-cost living quarters to the members of the organization The idea has had its fullest development in England, although some examples are to be found in this country.

This type of organization conducts a strictly renting business; it may and often does operate partially on borrowed capital, giving mortgages as security. The system is particularly applicable to small housing developments where apartment or multiple family houses predominate, and, in fact it loses much of its advantage where detached houses are the rule. The more important technical considerations are similar to those described for "Company-owned Houses."

When applied to industrial housing, the industry generally holds the majority of the stock and receives therefor dividends in the form of rentals. It has the advantage of relieving the industry of a considerable part of the burden of finance and operation, holds a somewhat better promise of returning an adequate rate of interest, and in addition it has some social advantage in promoting a more wholesome independence and self-reliance among the tenants than in the case of company-owned houses.

Forms of Building Organizations.—"Building" organization is here taken to mean that financial agency which initiates and is responsible for the construction of the housing development.

The schemes and types of organization that have been used

to finance and promote real estate housing developments are manifold as to details of execution and operation. However, for the purposes of industrial housing, they are represented by not over three fundamental types.

Loan and Realty Associations.—This form of organization loans money to individuals for building purposes or for the purchase of land only, up to a specified percentage of the total value of the property either unimproved, improved, or about to be improved, taking as security therefor either first or second mortgages, or both.

The more usual procedure begins with a borrower who has his land paid for and who desires to erect a dwelling thereon. In this case the borrower would obtain a loan from a bank, or from an ordinary building and loan association, secured by a first mortgage on his property. The realty corporation would then make the borrower a loan upon his second mortgage, for the difference between the cost of the proposed dwelling and the amount of the first mortgage, the second mortgage to be paid in monthly installments, or, payable at the end of a term of years, maturing when the first mortgage is sufficiently reduced to absorb the second.

As an alternative, the realty corporation may make a loan for the full value of the house, taking as security a first and second mortgage on the lot and proposed building, the first mortgage being payable at the end of a term of years and of such form as to render it easily marketable, the second mortgage being payable in monthly installments. The corporation then liquidates its mortgages to the fullest extent, as fast as received, and uses the money thus obtained as a revolving fund to continue operations. Its invested capital will thus amount to between 10 and 25 per cent. of the total value of mortgages held. The stock of the corporation may be held wholly or in part by the parent industry or industries, although the latter is the more customary procedure.

Responsibility for carrying on building operations generally rests with the borrower. However, in order fully to protect its interests, such an organization should exercise a watchful supervision over construction work, even to the extent of supplying technical skill, approval of plans and inspection of workmanship.

Housing Corporation.—This is essentially a building organization. A chartered corporation is organized with a stock issue so proportioned as to finance the required rate of building houses.

Stock is taken by the industrial concerns interested, by public-spirited organizations, if any are involved, and to the greatest extent possible by the public at large. The charter of the corporation should contain a limited dividend clause. With the capital thus obtained, a group of houses is built under the administration of the corporation. These houses are sold to men of good health and standing regularly employed by the industry or industries concerned, and of proven integrity.

Sales are made on a cash payment of a specified per cent. of the sales price, such price including all of the expense whatsoever or the allocation thereof necessary to produce and deliver the house; it would comprise interest charges, administration, overhead, taxes and insurance, proper allowance for guarantees to public service corporations, etc. At the time of sale the purchaser executes two morgages in behalf of the housing corporation; the first mortgage for 50 to 70 per cent. of the sale price and the second mortgage for a face value which is the difference between the total sale price and the sum of the first mortgage and the initial cash payment. The purchaser further pays a specified sum per month, usually about one per cent., to cover interest and insurance, (fire and life), the balance being applied to the reduction of the mortgage.

The corporation then negotiates the first mortgage and liquidates the second mortgage, insofar as possible, using the funds thereby obtained to continue building operations. As a variation, in large housing corporations, mortgage bonds may be issued against the first mortgages and sold to the public in small denominations, thus distributing and absorbing the financial burden.

A typical plan of this sort was outlined in a Bulletin issued by the U. S. Department of Labor, Information and Education Service, May 19, 1919.

"The plan involves an incroporated company with a capital stock of $25,000. Such workmen as can pay down 10 per cent. of the cost of house and lot will be loaned 50 per cent. by bankers on a first mortgage and the remaining 40 per cent. will be provided by the company, which will take as its security a second mortgage. The bankers of New London have agreed to loan the company funds up to 75 per cent. of the second mortgages offered in security. Therefore, the funds of the company tied up in any one property need not exceed 10 per cent. of the value of that property and the capital of the company will be

adequate for the promotion of homes up to the value of $250,000. In the meantime, those who build (or purchase) the houses pay off their indebtedness at the rate of one per cent. per month. Thus, the company will have availabe additional funds for further operations."

Company Housing Bureau.—In this case a housing organization, generally a corporation, is formed by the parent industry which owns or controls all stock in such organization. It may be chartered with powers broad enough not only to deal in real estate, but to build, sell, rent and to operate. Where the house enterprise must be subsidized, either directly by capital investment or by acceptance of a rate of return less than a legal rate of interest, this type of organization is generally the only practicable one.

Such an organization sometimes has been employed as a loan and realty corporation, through which the company will offer to loan money, up to as much as 90 per cent. of the proposed value of a house and lot, to any one of its employees who is a prospective builder and borrower. It has been found however, in practically every instance where tried, that this plan encourages purchase of houses already existing, rather than the building of more homes to relieve housing shortage which is the real object of the plan.

In case houses were actually to be built at the borrower's initiative, under this plan, the same reservations as described under "Loan and Realty Associations" should be exercised by the company housing bureau.

In conclusion it may be stated that the tendency is away from rather than toward a close control over the housing corporation by the parent industry, for the reason that too close a relationship between the industry and its subsidiary organization involves complexities which lessen the advantages of separate organizations as discussed in Chapter XIII.

TECHNICAL PROGRAM

The broader practical considerations in the initiation of a housing enterprise should receive proper attention early in the initial stage of the project. In fact, the preliminary surveys for the project should be contemporaneous with, or even precede, the equally important matters of policy having to do with methods of organization and finance and with house ownership. This phase of the procedure will require special attention to the following:—

An inquiry into the type and number of houses required, together with an estimate of the range and proper selling prices and rentals.

An investigation of locations and sites suitable for housing purposes.

A plan for economically developing the site or sites.

Finally, a trustworthy estimate of cost and budget of expenditure, together with at least an approximate program for construction, which will serve for a basis of financing the propostion.

Need for a Program.—The procedure to be followed in establishing a modern and industrial town cannot be haphazard. Too much is at stake to permit a community to plunge into it without careful and searching inquiry. The issue is not only the expense of the initial outlay for houses and towns, but is one of more paramount importance—having to do with the smooth functioning of the development throughout its life, in relation to the plant, so that both may achieve the purpose for which they are intended.

It has been unfortunate that many industrial concerns have built workingmen's houses, not only without mature thought and study on the part of executives, but also without any adequate assistance from those whose experience has fitted them to give it. Without doubt if an industrial corporation were to inaugurate a new system in the manufacture of its product or were to institute a new department in its work, this would be done only after a due study, in which specialists on the installation of the improvements in question would be called upon for the benefit of advice and judgement.

In many actual instances however, when the only hope of obtaining men to work in the plant lay in providing them with proper living quarters, it has happened that officials who showed good common sense in matters pertaining to their own business, the intricacies of which they well understood, have rushed into the problem of housing, a prey to unscrupulous or incompetent builders. As a result they have had foisted upon themselves and their communities nondescript developments, which later have failed signally to achieve the desired results. In some cases, the fact that all of the new dwellings were occupied, immediately after completion, led to the erroneous belief that an ideal village had at last been built; but as discontent later became manifest and it grew apparent that the only reason for occupancy of the houses was that they offered the only shelter available, those in responsible charge awakened to the fact that somewhere some-

thing was wrong. In the careful investigations which have followed such instances, much valuable information has been developed, which has raised the standards of later developments built by the organizations concerned, while the experience thus gained has proved valuable to others.

The lessons of experience, at least in connection with the house, as a unit, have been learned fairly well, but the importance of study and careful planning of the housing enterprise as a comprehensive and completely unified project, has yet to be fully appreciated.

Preliminary Work.—*Number and Types of Houses Required.*—The existing or prospective payroll, together with the number of satisfactory houses available will furnish the basis for determining, with a high degree of assurance, the requirements as to number and types of houses and the range of satisfactory selling or renting prices. The proportion of skilled to unskilled labor and the most desirable ratio of married to single men may be ascertained by an analysis of the needs of the various departments, based either upon the recommendations and opinions of the department managers, or upon a study of the kind of labor and labor processes best adapted to each. The percentage of women to be employed will determine the necessity or extent of women's dormitories.

The nativity and racial characteristics of the prospective working force will, when learned and forecasted, be one of the governing features in selecting the type of house and in districting the site. The mountaineer of Kentucky will require different treatment from the native of a Massachusetts city; the Mexicans of Arizona and New Mexico will demand accommodations and conditions different from those required by the Slavs and Swedes of Minnesota; the Italians of California have customs to be satisfied contrasting with those of the Negroes of Alabama.

Knowing the number of the various classes of employees, the ranks and standings, and something of their personal characteristics, the number and type of living quarters may be fixed. The wage scale will obviously affect if not control the total cost of the several types of houses as well as the total capital investment of the enterprise. This subject is presented as a definite problem in Chapter X.

Selection of Site.—If the industry is not established and if essential requirements do not fix the location, so that widest

latitude is allowed, this subject requires great breadth of vision and ability of a high order. Climatic, political and labor conditions existing in the different states and regions must be known and weighed, in connection with the special requirements of the industry. The cost of living and wages, the congestion, transportation and health conditions must be known. Existing industries and the law of attraction of similar industries should be considered.

Whether the town is to be an urban addition or an isolated rural community greatly affects the choice of site. Topography and soil conditions, pleasing vistas, freedom from local nuisances, such as mosquito swamps, factory smoke etc.; cost of land, political boundries, ownership of sites; nearness to existing communities, accessibility to and from the plant, transportation facilities, highways; availability and cost of developing water, sewerage, drainage, gas and electrical utilities; all must be given due weight and adequate conclusions drawn.

Projected Development oj the Site.—A preliminary development of the site selected should next be undertaken, for the purpose of determining more carefully the number of building lots and various types available, the approximate districting of the land, the location or relocation of thoroughfares and arterial streets, the availability and location of areas for parks, recreation and civic centers and the availability or location of the principal utilities. This stage of the woık will serve to outline the nature and the most economical disposition of the housing development, and will form an adequate basis for the preparation of a budget and a practical program.

Budget and Program.—The final stage of the preliminary work should be the preparation of a budget of cost and a program of expenditure. The budget will be based upon a preliminary estimate of the cost of the project, a knowledge of the method of financing, the amount of money that is or may be made available and the program of construction. The program of expenditure will be correlated with the program of construction and the stages, sequence and periods in which the various sections of development are to be completed will in turn depend upon the demand for homes.

Design and Construction.—The preliminaries concluded, policies determined, budgets made up and funds procured or appropriated, the project may then logically enter into its construction stage.

It cannot be emphasized too strongly, however, that construction should be preceded by the preparation of detailed plans and specifications, a precept which seems obvious enough, but which nevertheless is too frequently disregarded. The fundamental reason for planning any undertaking is obviously economy and the assurance of actually accomplishing the desired end. Perhaps nowhere in the construction field are there more fertile opportunities for accomplishing better results, frequently at an astonishing saving in expenditure, through planning, than in the construction of the large scale housing development with its manifold needs and activities, and therefore its manifold opportunities for waste.

Coördination of these various building activities, organization methods as applied to the construction program and the maintenance of an effective liaison can be made to yield returns, in savings, well worth while. For example, the relation between street and lot grading; the use of specialized squads of workmen successively, in house construction; the opportunities for saving in utility construction by use of a common trench and many other details; quantity purchases and the correct routing of materials; and in short the avoiding of all the mistakes of haphazard, time-to-time building.

Building Staff.—Town building, in its entirety, requires the services of various professions. No one of these can properly function without the coöperation of the others.

In connection with its war housing work, the United States Government found it necessary to organize the services of industrial managers, engineers, architects, town planners, transportation experts, realtors, sociologists and contractors, in order to achieve its purpose. All the phases represented by these different professions must be carefully coördinated and balanced, if an economical, comfortable, attractive, hygienic town is to result. All too often it has been found, even in recently constructed industrial towns, that certain phases have been overweighted to the detriment of the project as a whole.

Until very recently no town building organizations, containing men trained in the various professional branches essential to successful town construction, have been available. It has usually been necessary to engage independent specialists who in spite of a desire to coöperate, often worked at cross purposes; frequently causing delays, duplication of efforts, and unnecessary expense.

Industrial managers can readily understand the complications inherent in such an arrangement. Happily, especially during the War, the complexity of town building has been recognized; and comprehensive town building organizations have been formed which include, in their varied personnel, men trained in the particular branches essential to successful and economical town building. The field is large and the appreciation of the problem and of the advantages of such coördinated service is growing.

CHAPTER III

SELECTION OF SITE

Housing Site in Relation to Location of Industries—General Considerations Affecting Town Site Location—Investigations and Studies Preliminary to Site Selection

Introduction.—The success which attends the solution of the industrial housing problem will depend in a great measure upon the character and location of the site selected for the building operations. Irrespective of the merits of the housing policy which the company is desirous of following, that which may actually be accomplished will be determined in many ways by the restrictions and limitations imposed by the site. The selection of this must, therefore, receive very careful consideration and it should not be made until the general policies have been considered and the chief requirements for housing formulated.

HOUSING SITE IN RELATION TO INDUSTRIAL LOCATION

The selection of the building site may be subject to a variety of controlling and limiting conditions. It may arise as one of the elements associated with and related to other factors which determine the definite selection of a plant site; or, in very broad terms, housing conditions and opportunities for their expansion, may be a factor in regional location for an industry.

The two general conditions under which housing sites are usually selected are; first, where the industry itself is a projected one and a selection for its location has not been made, and second, where housing is to be provided for going and established plants. The investigation which should precede site selection in the first instance is more involved and complex than in the latter, since there are more conditions, often conflicting, to be satisfied.

When a new industrial plant is to be located, the housing of the industrial workers must receive just as careful consideration at the outset as the other factors which affect or concern the loca-

tion of the plant and the problems of operation and production. The opportunity is then present to solve the housing problem in a satisfactory manner. If left to chance, or to later determination, this may prevent the development or successful operation of the industry in its illy chosen location; or, it may make the cost of housing very expensive. Housing is therefore to be considered as one of the important factors concerned in plant locations and in production.

Industrial and Economic Requirements of Plant.—The selection of the region, the vicinity, and finally the definite site, in which the proposed plant is to be built, involves in many cases the fulfillment of certain requirements peculiar to that industry, and conformity to various economic and business conditions that enter in varied measure into the operation of all industries. Special requirements for certain industries will operate to limit the location, either to definite situations or to regions possessing peculiar requirements which are absolutely necessary for the conduct of that industry. Mining plants, for instance, are necessarily restricted to those districts where the ore or mineral deposits are found; the shipbuilding industry must perforce be located on a site possessing a navigable water front of sufficient depth and width. For certain industries, using large quantities of water in its processes, the plant site must be adjacent to a sufficient body of water, or to economical possibilities for the development of a sufficient water supply. The cheapness and availability of fuel or power will exert a strong influence and be a determining factor in the selection of sites for many industries. Industries which are hazardous in their nature, or productive of unavoidable odors, noxious gases, and other nuisances will seek isolated locations.

Economic location with regard to transportation of raw materials and to distribution and marketing of the finished product, will be the determining factor in the selection of the location of many industries. As to whether nearness to source of raw material, or location at points favorable for distribution will predominate, will depend upon the nature of the industry, and be largely influenced by the form and bulk of the product manufactured. Industries inherently reductive in their processes, requiring bulk of raw material which becomes greatly reduced in weight and volume in process of manufacture, will have a tendency to locate in proximity to the source of the raw material.

Where raw materials of several kinds are used in bulk, the location may be made at any one of the sources of supply, or at points where convenient transportation facilities are available for all of them. In any event transportation and terminal facilities will be most important considerations.

In some industries climatic conditions, the amount of rainfall, humidity, the extremes and variations of temperature will have an important influence on the plant operation and will so affect the choice of site.

The location of many manufacturing industries, particularly those where skilled workmanship enters into the final manufacture and assembling of the finished product, will be to a great extent controlled by labor conditions. This factor is perhaps best expressed as that of the operation of the law of "The Attraction of Similar Industries." This may be a controlling factor even though conditions in the locality are not otherwise relatively as favorable as others for economic production. The location of the New England cotton manufacturing industry, in a region far removed from the source of supply, is a well known early instance of the operation of this law. It therefore follows that where a section has become a leading industrial center for a given kind of manufacture, the availability of specialized and skilled labor at that point will continue to attract new enterprises of the same or related kind.

The particular requirements of an industry, which determine the definite selection of its site will depend upon the nature of the works and the size and capacity of the plant. The requirements as to the topography of the site and its size, shape, and the possibility of future extension must be fully considered. Where the requirements are such as to demand location immediately on the line of a railroad, or where there must be opportunities for convenient and cheap disposal of waste product, these conditions must be met.

Housing as a Factor in Plant Location.—Housing has been recognized as one of the factors which must, of necessity, enter into the selection of the location of the industry. The problem is to select such a location for the industry as will fulfill the industrial and economic requirements of the industry itself and at the same time make ample provision for a supply of efficient and loyal workmen.

There are a number of ways in which this may be accomplished.

The more common method, prior to the present day conditions, was to locate the industry in or close to a populated district, under conditions in which the housing requirements would take care of themselves by becoming merged with those of the community. This policy can be followed only where there is either a sufficient number of suitable houses available for occupancy, or where building and business conditions are such as to insure construction by individuals. Such a plan conveys no assurance of satisfactory housing conditions and failure of realization may react to the detriment of the industry.

Another plan is to locate the plant in a district where many of the utilities and necessities and community advantages are available, and can be in part used, and then to build either directly, or in conjunction with other manufacturers, suitable housing facitilies.

The third plan which has been followed in recent years by several of the larger industries, has been to select a site in a rural region, so far removed from existing facilities, as to constitute the development of an isolated site.

Whatever may be the plan adopted for housing, the underlying factors of the housing problem will include consideration for requisite area; suitable topography; accessibility to the plant and to any neighboring communities, whose facilities for recreation and religion are to be depended upon; the possibility of establishing proper health conditions and of providing a reasonable measure of amenity and attractiveness.

The requirements of a site suitable for housing are hereafter discussed in some detail and it is proposed to point out in this chapter only the chief requirements as to housing, which must be considered conjointly with the other factors when the selection of the site of the plant is made. These fundamental factors will include the cost of the land, the cost of the development of the site with all improvements and utilities and the erection thereon of buildings and the cost of transportation; the extent to which community facilities, such as schools, churches, recreation places, etc. must be provided, will also have an important bearing. The cost of providing housing, as comprehended by the foregoing classification, together with other costs, of industrial construction should be weighed for possible location in order to determine that which is best adaptable and most economical to construct.

GENERAL CONSIDERATIONS AFFECTING TOWNSITE LOCATIONS

Working conditions within the plant and living conditions within the town greatly affect the stability of labor. Phases dealing with such working conditions: as hours of labor, wages, bonuses, piece payments, labor saving devices, safety devices, elimination of disagreeable tasks, etc., all lie within the sphere of the industrial engineer and plant expert, as do all the previous considerations heretofore mentioned. Factors affecting living conditions —as houses, stores, other buildings, sanitation, utilities, and recreational and educational facilities, etc.—are phases which call for the consideration of town building specialists.

The selection of a town site is both a technical and economic problem; it is complex because of the number and interrelationship of the various factors involved; and there is just as much necessity for the exercise of skill and experience in the determination of the site as in any of the many problems of production or operation of industry which require the services of specialists for their proper solution.

Distance Between Plant and Town.—The location of the plant, fixed either by technical plant considerations, commercial advantages, climatic conditions or presence of similar industries, may be established either in or adjacent to a town, or in an isolated location.

The choice of a site for the industrial town, to serve either of the above plant locations, is limited by a time zone, any area within which is within a certain time distance from the plant. The town preferably should not be more than 15 to 20 minutes walking distance from the plant, or not more than 30 to 40 minutes by convenient and dependable transportation service.

Factors which Relieve Distances.—The allowable distance from the plant to the worker's home will be affected by conditions other than the time it takes to cover it in walking. When access to the plant from the home may be made in a comfortable, agreeable and convenient manner, the lessening of fatigue will tend to minimize the effect of distance. There should, therefore, be provided well planned routes leading from the homes to the plant, where walking conditions will be good, safe and convenient. Where approach paths or roadways are provided, they should be laid out in easy grades, be well drained and surfaced and grade crossings should be avoided.

Shower baths at the plant alleviate the fatigue of long trips home and many companies have now established modern washing and bathing facilities for this reason. Most workmen nowadays like to go to and from their work dry and clean. Such self-respect is commendable and should be encouraged by providing suitable means whereby it may be satisfied. In addition to its cleansing effect the shower bath refreshes the tired workman, so that he makes the journey home after a hard day's work in a more agreeable frame of mind.

Many companies, employing large numbers of women workers, have facilitated the movement between homes and the plant by allowing the women to quit work before the men. This avoids much of the rush and jostle for women workers at the plant gates when the whistle blows.

In isolated towns the company should see, where transportation accommodations are necessary, that they are provided at reasonable cost, and are adequate and comfortable. Labor trains have frequently been neglected features; employment will be made more attractive if measures are taken to insure cleanliness and protect overcrowding.

Map Showing Area of Choice.—With the plant site fixed and knowing the time limits between plant and townsite, an area can be shown which will include the limiting possibilities of choice for the townsite. The size and shape of this area will be affected, not only by the topography, but by the type and character of the transportation facilities that exist or that may be economically developed. The distance from the plant to the outer limits may vary from one to fifteen miles, according to the means of transit.

After ascertaining the limiting area for town site possibilities by means of the map, a general question to be considered, before the particular site for the town is selected, is whether or not it is expedient and advisable to locate the plant and town adjacent to each other or to have them apart.

Advantages of Town and Plant Adjacent.—A town built close to the factory permits the employees to walk to and from their work. It reduces the cost of living, as it cuts out daily transportation expense. It eliminates, on the part of the company, the necessity of building or meddling with transit facilities. It permits the workers to go to their homes for their mid-day meal, thereby saving expense and perhaps securing food

more to their tastes. It obviates the necessity of conducting lunch rooms for most of the men at the plant. It provides that workmen are close at hand in case of accidents, breakdowns or other emergencies. It may permit less costly construction, as erection of the town and plant at one location simplifies the shipment and hauling of building materials and may reduce the cost of supervision. The proximity of the town to the plant will generally reduce somewhat the cost of lighting, heating and fire protection for the town and other utilities. It permits the company to have all its holdings contiguous, possibly simplifying the acquirement of land.

Disadvantages of Town and Plant Adjacent.—Such proximity restricts the choice of sites. Frequently land suitable for an industry may be unsuitable for the town, or at least much more adaptable, and attractive spacious townsite areas may be acquired if the choice is not so restricted. Adjacency permits the atmosphere of the plant to pervade the home. It fails to furnish the daily break between working and living which is so advantageous to both. Many of the dangers and nuisances and necessarily unsightly features incident to the factory are not escaped. Noise, smoke and odors from the plant may make the town less attractive.

Decision Rests upon Many Factors.—No definite general recommendation can be made in regard to this question of proximity. The decision must depend upon the character of the plant, the nature of the plant site, the character of the country within suitable distance of the factory, and the status of the transportation facilities. Both possibilities should be carefully investigated with an open mind. While first costs should be kept in mind, economical and agreeable living conditions throughout the life of the town are of greater importance. As a general rule, a townsite reasonably removed from the plant is conducive to the best and most wholesome living conditions.

Urban versus Rural Towns.—There may be a choice of building the industrial townsite in such a position that it may be annexed to a growing city; or of establishing the town in an isolated location, so that it will remain a strictly self contained, separate town.

Policy of Home Ownership.—The decision in this matter hinges largely upon whether or not the policy of the company

is to maintain ownership of the houses or to sell them. An urban or suburban development lends itself more favorably to a sale's policy, because such a site affords diverse occupations to members of the workingman's family. Moreover, the urban site provides a wider opportunity for greater social and recreational activities, and less expense to the local community.

Construction and Maintenance Considerations.—In spite of higher land value, the cost of developing within or adjacent to an existing community will generally be less than that of an isolated town. It occasions less expenditures for schools, churches, theatres, hotels, stores, clubs, etc. The installation of the utilities such as water supply, sewerage, gas, and electrical services, can be carried out as a rule less expensively. Moreover, the upkeep and maintenance cost of municipal utilities may be assumed, if within its limits, by the municipality.

Disadvantages of Company Towns.—If the houses are sold to the workers and the industrial housing project is within or is later annexed to an established community, the company is relieved of all the trouble connected with the administration of the town. At its best the duty of managing an industrial town is an onerous one; it complicates rather than simplifies plant administration; it gives rise to a multitude of situations involving not only the workman but his family. It multiplies points of contact a hundred fold, and unfortunately these are productive of friction rather than good will; the dual role of landlord and employer in large industries is a difficult one to fill; it brings the plant atmosphere into the home. It is perhaps the very reason why so many industries have held aloof from the whole question of industrial towns. "Enough difficulties occur in the plant," says the Manager, "without adding to our trials."

For the above reasons it will be found advisable to select a site and follow a policy that will guarantee wholesome living conditions for the workers, with the smallest possible amount of company intervention. This can be and has been done successfully; it generally means the establishment of a subsidiary land or real estate company, whose functioning and officials are separable from the industry. Generally speaking, other conditions being favorable, and urban or suburban industrial townsite, is to be preferred. Isolated sites should be chosen only as a matter of necessity.

INVESTIGATIONS AND STUDIES PRELIMINARY TO SITE SELECTION

With the limiting area for sites of the town established and when such questions as the advisability of building an urban addition or an isolated town, and of location relative to the plant have been considered, other factors affecting the details of selection of a definite site follow in consideration.

It may well be that the determination as to the above will not be settled finally until data on a number of sites are presented. Thus it may prove advisable to consider a site best suitable for an urban addition; another in a location most suitable if the town is to be close to the plant; and, finally, a third, most adaptable for an isolated town site.

Necessary Acreage.—To determine the area necessary, the number and types of houses to be built, and the requirements as to size of lot, must be known; the quarters necessary for single men, the number and size of public buildings, stores, parks, etc., must be approximately predetermined and to the area thus found there must be added the space necessary for reasonable future expansion. Knowing these facts the minimum area required for a complete townsite is found. So much for minimum acreage required.

General Statement.—Irrespective of the acreage actually necessary, the acquisition of additional land is generally advisable. Future unforeseen developments are thus protected. The general tendency is for such land to increase in value and it may be sold later at a profit if advisable. It protects the development from undesirable conditions growing up at its borders. A practical procedure to follow is to determine the minimum acreage required and then to acquire as much more as possibilities of future expansion warrant and as can be conveniently obtained and financed.

Government Examples.—As a suggestion in determining the minimum acreage, interest attaches to the average building density per acre provided for in the 128 town site projects originally planned by the United States Housing Corporation which was 5.6 families per acre of gross area. The type of houses built affect the density per acre; thus rows of group houses furnish a larger number of families per acre than semi-detached or single detached houses.

Tables 6 and 7 give the details for some of the projects built by the United States Shipping Board, Emergency Fleet Corporation and the United States Housing Corporation.

TABLE 6.—STATISTICS OF SOME EMERGENCY FLEET CORPORATION HOUSING DEVELOPMENTS SHOWING EFFECT OF TYPE OF DWELLINGS ON NUMBER PER ACRE

Project	Developed area acres	Total number of houses	Per cent. of types of houses: Detached	Semi-detached	Rows	Number of houses per developed acre[1]
	1	2	3	4	5	6
Bath, Me.	16.4	109.0	15.5	84.5	0.0	6.
Camden, N. J.	180.0	1,386.0	4.5	21.8	73.7	7.7
Dundalk, Md.	70.9	529.0	6.0	28.3	65.7	7.5
Gloucester, N. J.	70.0	447.0	24.3	37.5	38.2	6.4
Lorain, Ohio	41.4	221.0	60.1	39.9	0.0	5.3
Newburgh, N. Y.	23.7	127.0	0.0	47.2	52.8	5.4
Portsmouth, N. H.	47.2	276.0	9.4	81.2	9.4	5.8
Sun Hill, Chester, Pa.	22.2	270.0	0.0	14.0	86.0	12.1
Wilmington, Del.	57.4	503 0	1.3	20.6	78.1	8.8
Wyandotte, Mich.	13.4	78.0	100.0	0.0	0.0	5.8
Average	54.3	394.6	22.1	37.5	40.4	7.1

[1] Includes street area, open spaces and area devoted to school and recreational purposes.

The following statement is quoted from the Ontario Housing Committee's Report, issued in 1918.

"Leaving ample allowance for streets and open spaces, 12 houses per acre would permit lots of 2500 sq. ft. In comparison it is interesting to note that the Federal (Canadian) Standards suggest a minimum lot of 1800 sq. ft. in cities and towns, and 4500 sq. ft. in villages."

Allowing the area required for the streets, lots and parks in the residential section of an industrial town, the fore-going allowances will result in a density of from eight to sixteen families per built-up acre. An average of twelve families per occupied acre will not necessarily cause congested conditions.

Table 8 denotes the average distribution of area in terms of percentage of total area of various townsite projects planned by the United States Government during the recent War;

97 contemplated by the United States Housing Corporation and 12 of those built by the Emergency Fleet Corporation.

TABLE 7.—STATISTICS OF SOME UNITED STATES HOUSING CORPORATION DEVELOPMENTS SHOWING EFFECT OF TYPE OF DWELLINGS ON NUMBER PER ACRE

Project	Developed area in acres	Total number of dwellings	Per cent. of types of houses			Number of houses per developed acre.
			Detached	Semi-detached	Rows	
	1	2	3	4	5	6
Aberdeen, Md	26.5	80.0	81.3	0.0	18.7	3.9
Alliance, Ohio	71.4	265.0	100.0	0.0	0.0	6.3
Butler, Pa	21.5	167.0	17.4	82.6	0.0	10.3
Charleston, S. C	30.6	136.0	100.0	0.0	0.0	8.0
Charleston, W. Va	16.3	87.0	54.0	46.0	0.0	9.6
Elizabeth, N. J	19.0	204.0	0.0	50.1	49.9	15.0
Lyles, Tenn	61.1	125.0	100.0	0.0	0.0	6.7
Muskegon, Mich	50.8	278.0	100.0	0.0	0.0	8.1
New Brunswick, N. J	43.0	397.0	10.3	38.1	51.6	7.8
New Castle, Del	14.7	46.0	43.5	22.1	34.4	5.1
New London, Conn	23.2	188.0	10.7	89.3	0.0	11.8
New Orleans, La	42.9	209.0	100.0	0.0	0.0	7.7
Newport, R. I	9.4	78.0	12.8	87.2	0.0	12.0
Newport News, Va	192.5	1,015.0	30.2	30.7	39.1	9.9
Niagara Falls, N. Y	53.2	401.0	24.3	20.5	55.2	12.7
Niles, Ohio	25.3	117.0	88.0	12.0	0.0	6.5
Quincy, Mass	62.1	398.0	82.1	17.9	0.0	9.7
Rock Island, Ill., District	161.1	997.0	82.4	17.6	0.0	9.4
Average	51.3	287.1	57.6	28.6	13.8	8.9

TABLE 8.—SUBDIVISION OF ACREAGE—GOVERNMENTAL HOUSING PROJECTS

Purpose	Per cent. of area	
	E. F. C.	U. S. H. C.
Residential lots	55.1	62.3
Other building lots	5.2	2.2
Streets and alleys	26.8	25.5
Public grounds	12.9	10.0
Total	100.00	100.0

Shape and Costs.—Having determined, from a study of the requirements tentatively considered as controlling, the area needed for the development, the next question arising under selection of site is to compare different possible areas on the basis of shape (*i.e.*, adaptability), cost to secure and possible method of acquisition.

Boundaries.—The suitability of a possible site may be lessened by reason of the shape of the available tract which can be acquired. The boundaries may be determined by the ability to make reasonable purchase so that the development of the tract may be carried out in a satisfactory manner. Otherwise, considerable expense may be incurred without adequate return. The possibility of being unable to acquire rights of way for access, or for utility lines, etc., at reasonable rates should be inquired into and will likely affect selection. Precautions should be taken to determine the possibility of damage to abutting or nearby property arising from drainage or other cause. The situation can often be improved by inducing adjoining owners to participate in bearing part of the cost of those improvements which benefit their properties: such joint distribution of costs may make desirable the development of a site which otherwise could not be considered.

It must, however, not be supposed from the above that the rectangular or regular shaped piece of ground is most economical or desirable in all cases, as many other factors affect the decision and some of the physical characteristics mentioned in the next section play a greater part.

Cost of Land.—Cost of securing land is an important factor, but again not controlling, as that which is cheap in first cost may be expensive to develop and to provide the facilities required therefor.

Land in isolated, rural territory is generally less expensive than that adjacent to cities, particularly if purchased before knowledge of the location of the industry has been made public.

Method of Acquisition.—Two methods of acquiring land present themselves—one in which options upon or purchase of ground are obtained before announcment of factory location;—second, by coöperative action and pooling of interests in land for the common good, in order to secure the establishment of an industry.

The first is the common, well-known method of optioning or purchasing through an agent and so getting control of sufficient land at reasonable and normal prices before the identity and

intent of the future promoter is revealed. In the second, the possibility of competition of sites both for factory and town is held out to the people and owner, and thus an interest stimulated to combine interests and present the favored grouping of lands for consideration at the most reasonable price.

Physical Characteristics.—The natural conditions of the ground affect profoundly the relative desirability of sites, not only as to first cost and up-keep, but also as to comfort and convenience.

Topography.—It has been stated previously that rugged hills and like barriers may control a development and it is well known that the utilization of river bank and bottom land for factories has frequently left only the hills and gullies as a chance for houses, and added much to the expense and unpleasantness of life. On the other hand monotonously level ground is not ideal, either from the investment or attractive point of view. A slightly rolling area permits of less expensive drainage than one with a generally flat surface, as well as affording more variety in treatment of allotment and division into streets, lots and open spaces.

Soil Conditions.—The kind and depth of soil available affects the beautification of the town and horticultural developments of lawns, playgrounds and parks. The depth to rock and the character and stability of the earth will greatly affect the cost of utilities, site grading and building cellars and foundations. The depth of water table not only affects cost of trenching and laying pipes, but involves the added costs of sub-drainage of building foundations, and other precautions to obviate wet cellars. It also is a large factor in infiltration into sewer systems and may thus affect not only the cost of treatment works but also the maintenance thereof.

Climatology.—The average and extreme ranges of temperature and precipitation determine to a large extent the character of house required. It is readily appreciated that the materials of house construction in Canada differ from those of the Tropics, but it is also quite as true that use of shutters and overhanging of eaves also varies with amounts and frequency of precipitation. Other items of climate affect location.

The prevailing direction of winds, especially in connection with the subject of nuisance, frequently plays an important part in the desirability of a site. The topography affects this also, as ravines or steep hillsides may and frequently do cause accumulation of smoke and fog banks, so as to render unavailing

the ordinary currents of air which dissipate and break up such objectionable features. The availability and frequency of sunlight are important, as it adds to the cheerfulness. Vegetation, somewhat akin to this subject, may affect the location to an extent, as heavily wooded areas add to the expense, because of the necessity of clearing. But some woods and retention of such trees as will not interfere with construction, are an advantage for breathing spots, parks and residential streets. The existing types of plant life indicate those which will grow easily in the region.

Demography.—The recorded sickness and death rates of the adjacent settlements, *i.e.*—the known reputation of the community as to healthfulness—have an important bearing on the desirability of a site. So likewise the appearance of the ground and water courses, as to sanitary condition and the prevalence of the mosquito nuisance, although controllable, affects profoundly the general suitability of a tract—at least in the minds of the early visitors and prospective inhabitants.

Nuisances.—All of the factors that cause nuisance, such as objectionable noises, smoke, fog, odors and noxious gases are interrelated to topography and climate. Frequently, however, local conditions of proximity of certain types of industry making objectionable noises, such as boiler shops, rolling mills, etc., or uncomfortable odors or vapors, such as laundries, canneries, reduction or metal furnaces, may make nearby locations for townsites decidedly unsuitable unless these be on the leeward side. The noxious gases from certain industries may not only be injurious to fabrics and to health, but also to vegetation. Such are not to be permitted in the vicinity of attractive townsites.

Means of Communication.—All available means of transportation, whether by water, steam railroads, electric traction lines, highways or foot-paths, aid in determining the selection of sites between two or more available ones. Such conveniences may even affect the question of embarking upon schemes of amusement and recreation; for if available at a place not too far away by means of easy communication, it is not necessary to build new ones.

Steam and Electric Railroads.—The distances and grades of thoroughfares to present railroads, the possibility of location of branch lines, availability of terminal facilities, schedules of service and fares to important centers of population are leading criteria in selecting townsites. Facilities for interchange of

traffic and freight between available means, such as water ways as well as railroads and highways, are valuable adjuncts to any town. Then, too, an available water-front affords means of suitable development for parks and recreation and large bodies of water present opportunity for disposal of waste which with present means of treatment, may be without objectionable results.

Highways.—The character, exent and width of highways in furnishing adequate and convenient means of communication between village and factory and even the not too far distant city, are becoming more and more important in the selection of housing areas.

In the present days of automobile trucking, industry even may locate away from a railroad siding and have its hauling of supplies and product done by the use of motor trucks.

Existing Facilities.—The selection of a townsite in many cases, especially when rapidity of completion is important, is determined by the question of whether there be available various public utility systems of sufficient capacity for extension into new territory. This of course arises particularly where the industry is considering a location near or adjacent to a city.

The possibility of extending existing utility systems furnishing a satisfactory water, gas, or electric supply, and of utilizing or connecting with existing sewerage and drainage works, should be carefully investigated and the relative advantages of various available sites should be compared. It will be found upon investigation that many sites, otherwise suitable will be relatively much more expensive to develop than others on account of their location relative to the existing utilities. In this connection feasibility, cost and length of time required to afford service must be considered and given due weight.

The existence of the nearby city, with all of its public out-door and in-door recreative, and educational facilities within reach, means that the needs of the new settlement can be met without building for it alone. Proximity to such facilities has a considerable money value, since the necessity of creating them—and they are generally of non-revenue nature—is avoided.

Many other factors affect the determination of location and, like the above, simply play their part in the weight of opinion. Not all will be found of a favorable character in any one place but each should be considered.

Attractiveness.—If there be choice without undue additional expense a site most adaptable to the attractive development of natural advantages should be chosen; thus pleasantness and attractiveness and at the same time opportunity for out-door enjoyment and exercise may readily be obtained. Locations near lakes or streams, interesting vistas, and pleasing topography may sometimes appropriately dictate final selection. While it is to be realized that attractiveness has a positive value, care should be taken not to allow fulfillment of interesting scenic possibilities to outweigh the ever present considerations of economic costs for the development of the area.

Prejudices and Customs.—Cognizance should be given to any local prejudices particularly in respect to the race question. A forecast with respect to the type of labor to be employed is necessary to avoid this. Social and religious and political customs of the people must be considered. For example; the strong religious feelings of the Kentucky mountaineers and their aversion for work on Sundays in the coal mines recently developed there, is in contrast with the indifferent attitude of the miners in some of the western states.

Preference for house types, frequently unexplainable except by custom of peoples or community must be reckoned with and planned for; the California bungalows, the Philadelphia rows or groups, the New England cottage, seem to possess a local attraction not common everywhere.

Surroundings.—Care must be exercised in passing upon the suitability of a given site to insure that the attractiveness and value of the property, and the living and social condition of the inhabitants will not be diminished by the nature of the surroundings. The existence of nearby built-up districts of undesirable character is to be particularly avoided as detrimental to attractiveness, permanency of value and as neutralizing efforts to maintain good social and moral conditions.

Laws and Restrictions.—Building restrictions, plumbing and health regulations, etc., frequently control the construction details of houses, sometimes to an unnecessary and expensive degree. This may be so onerous in certain incorporated communities as to dictate a location outside of their political boundaries. Legal powers, permitting the accomplishment of certain aims in the development of housing plans and utilities are favorable in some places and not so well adapted in others, thus

vitally influencing the decision between different locations. Local customs and business restrictions may often cause construction to be unduly expensive.

Conclusions.—The selection of a town site for housing industrial workers is a many sided problem. It should neither be decided precipitously without taking in account all of the factors, nor should the location of the proposed plant be decided without a study and a determination conjointly made where labor is to be housed. With a given type of plant and number of workers, character of product and market conditions, and kinds of labor required, the general range of locations can be found.

The next group of determinations cover those coming under the head of urban or rural selection and those like adjacency and remoteness. These two are affected by policies of ownership and renting which must be decided at the same time.

Then come the various detail factors that should be considered and weighed in the balance of judgment in selecting an industrial site. Too often in the past decisions have rested upon the influence of too few, sometimes even upon whims and aesthetic tastes, much to the increase of final cost and occasionally with the result of complete failure of the project.

The definite selection of the site should be based upon something more than mere weight of opinion. The relative advantages of the available sites should be compared by means of preliminary estimates of the comparative cost of their development combined with the cost of purchase. This will involve making estimates, necessarily hurried and incomplete, but, sufficiently close and dependable to indicate true comparisons. It must be realized that there are large differences in cost of developing various sites, in excavating cellars, installing utilities, etc.; that some sites will require much more to transform into a community than others. The cheaper land will not always be the most economical in the end as the amount saved in its purchase may be absorbed in expenditures which better located and more expensive land may not require.

It is the hope and expectation that the remaining chapters of this book will not only show the need of studying all factors but the probable weight needed to be given to each; with the result that a happy and judicious decision will result in any given case after a review of all the conditions.

CHAPTER IV

DEVELOPMENT OF THE TOWN PLAN

ALLOTMENT OF AREAS—THE STREET SYSTEM—SUMMARY OF PROCEDURE—RECENT COMMUNITY DEVELOPMENTS

Introduction.—While a well developed town plan is the first essential in the preparation of a definite program for a project, such a plan can be worked out and finally adopted only after many underlying problems and relationships have been considered and solved.

A completely evolved town plan will ordinarily include the following main features:

(*a*) Division of the area into districts according to character of use.

(*b*) System of main or arterial streets.

(*c*) Systems of secondary or sub-arterial, business, and residential streets.

(*d*) Sub-division of the blocks into building lots.

(*e*) Transportation facilities; including street and trunk railways and railroad stations, or both.

(*f*) Parks, playgrounds, civic or community centers, schools, public or semi-public buildings and special features, as required, such as locations for public utility structures.

(*g*) Gardens or yard developments, either in rear yards or allotments.

The extent to which the various foregoing features are to be introduced into the plan of a housing development will depend very largely upon its size and its location relative to other and adjoining communities. The various elements and their underlying requirements heretofore noted are more or less interrelated; their incorporation in a town plan is a problem of coördination and adaptation. Too much emphasis cannot be laid upon the importance of consistent and coördinated planning, upon the necessity for careful consideration of the essentials of each element or feature; and upon the merging of the whole into a well balanced program.

The simple, but often neglected, relationship between street

grading and house location will serve as an illustration of the interdependence between different items of the plan. Thus streets should not only be located and graded so as to fulfill the requirements of traffic, access and drainage—their prime functions—but also should be fixed, with proper regard for economic and desirable house location, particularly to minimize the cost of lot grading. The surplus or deficiency of materials in street excavation may well be a factor in the development of designs for lot grading. Also the use of alleys, with their attendant expense of construction and maintenance, will depend very largely upon the type and grouping of the buildings. Illustrations, such as the foregoing, could be multiplied indefinitely, showing the necessity and the practical benefits to be gained by the working out of a carefully considered and comprehensive town plan.

There is an opportunity for accomplishment in the planning of an entirely new community which is not presented by ordinary municipal subdivisions or real estate developments. Many of the factors, such as the character of buildings, or the amount and movement of traffic which are frequently problematical in the latter instances, can be made determinate in the planning of an independent, industrial town. The new community can, therefore, be intelligently planned to meet definite requirements and conditions, and again, the problems and the order of their consideration will be quite different than in the revision or re-planning of older communities.

On account of the great variance in the physical, economic and other conditions vitally affecting the town plan, it is impossible to lay down hard and fast rules for general application. There are, however, certain criteria which may be applied and certain standards which must be met.

The street system must be so planned that it will answer the every-day requirements of traffic, business and access to the houses. The physical well being and health of the community must be assured by providing sufficient light, open space and air, and by arrangements and utilities which will promote good sanitary conditions. The limitations of cost and financial return must be kept in mind, and the expenditure so proportioned between the various requirements that it will be most effective in promoting the health, convenience, amenity and contentment of the inhabitants. In other words the plan must make complete and economical provision for all needs of the residents.

ALLOTMENT OF AREAS

General.—The initial step in the development of the plan, after securing the topographical and other fundamental information, is the division of the area into districts according to character of use. Suitable areas must be reserved for industrial, commercial and residential developments, for parks, schools and other recreational and community purposes, and sites must be selected for public and semi-public purposes such as the civic center and its buildings, railroad stations and public works.

In such districting, topography, elevation and existing or projected transportation lines, will exert great influence. The shape and location of the various districts will often depend, to a considerable extent, upon the development of a satisfactory system of arterial streets for through traffic and connection with other areas or communities. The work of division must, therefore, be carried out in close connection with the arrangement of the arterial street system.

Districting and Zoning.—The number and kind of districts and residential sub-districts which will be required will be controlled by the contemplated size of town and variety in type of industries and houses, the required size and shape of lots, and the cost of land. Districting consists, primarily, in utilizing the various portions of the town and parcels of land in such manner as best to serve the health, welfare and safety of the the community to the best purpose. It furthermore should include definition of restrictions or zoning, to establish the districting policy and to insure permanency in the use of property.

It is necessary, not only to make the most effective use of the property and to build on the most adaptable ground, but also to protect the future purchaser. Zoning regulations should be promulgated and enforced from the beginning, and should restrict, among other things, the percentage of lot occupied, the height of buildings and the use and occupancy of buildings. This will define the development of districts for many years to come. Such regulations are now being enforced in a number of American cities and are being upheld by the courts. They insure that the purposes of the development will be attained and at the same time protect the interests of the community and the individual.

Such regulations while an exercise of the police power must in the first place, necessarily be based upon careful designing and

study of probable use. The separation between various districts should not be made too evident, in order to avoid the creation of a prejudice against the property of lower value. A water course, ridge line, woodland strip, park or other topographical feature may be employed for the purpose. The various residential districts should preferably be contiguous to each other, thereby reducing the outlay for schools, fire protection and, generally, the cost of utilities.

The more expensive houses will naturally be built where the values will be affected the least by nuisances from the plant, such as noise, smoke or odors. The relative advantages of exposure, prevailing winds and similar physical factors should also be taken into account in selecting areas adaptable for the various types of houses.

If the plant is adjacent, its relation to the several residential districts deserves serious consideration. The proximity of the various districts to the main lines of transit, railroad or street railways, or both, must also be taken into account; especially the latter, if transportation must be used by the workers to reach the plant. In making this study, an important consideration is the time required to walk from the work to the homes. The higher paid employees will generally be found willing to travel a considerable distance to obtain a more attractive home and environment. The growing extensive use of the automobile by the well paid is also to be considered. On the other hand, the unskilled workman prefers to live as close to the plant as possible. It is preferable that the walking distance from the houses of the the lower paid men, particularly the laborers, should not exceed fifteen minutes.

Districting is an essential element of the town plan, and is intimately related to the arrangement, width and character of the streets.

Sub-division of Property.—Property sub-division embraces the determination of the shape, size and proportions of the lot and block, and also the division into sub-areas, according to the character of the proposed improvements.

In deciding upon the best use to which the various parts of the area may be assigned, topography and physical conditions of the ground must be fully taken into account. These affect the grades of the streets and cost of site grading for buildings. For instance, detached or semi-detached dwellings can be built

frequently on land which may be unduly expensive to develop for row or group buildings, or for business blocks. Extension to adjoining areas of suitable ground should also be considered, in locating the various sub-districts, particular study being given to the probability and extent of such future developments.

Where conditions are such as to make immediate improvements inadvisable or unduly costly, the disposition of such parts of the area as are unsuitable for building purposes should be determined when the tract is districted. These conditions may obtain upon account of inaccessibility, rough topography with ledges or rock strata close to the surface; or the presence of low lying ground, swampy, difficult to drain, or subject to flooding. Examples of making such areas available for use include the filling of low land from surplus street, trench and cellar excavations, or by hydraulic fill from an adjacent river, and drainage of swampy ground by trenching.

Allowance per House.—The net cost of the land required for each building lot and improvements must necessarily be a governing consideration in determining the size of the lot. This can be determined only after all allowances and deductions have been made for land used for non-return purposes and for that which is unsuitable for improvements. It will be helpful, in studying the problem, to form an idea of the extent and reasons for such deductions.

The area reserved for streets and alleys will vary with the topography and the depth and length of the blocks, and will depend upon the depth of the individual lot and hence upon the type and grouping of the proposed buildings. In this connection, the statistics of eleven typical villages planned and constructed by the Emergency Fleet Corporation, as given in Table 8, Chap. III, will be of interest.

It will be noted that the percentage of the area devoted to streets and alleys in these projects ranges from 20.1 to 44.2 per cent., and that the average for all projects was 26.8 per cent. The average of twenty town plans, selected as typical from those made by the United States Housing Corporation indicate that 25.5 per cent. of the area was set aside for streets and alleys.

Provision must also be made for parks and open spaces, and for schools, churches and other public and semi-public buildings. The area set aside for these purposes will vary widely depending to some extent upon the isolation of the new development

and upon the degree to which facilities for recreation and diversion, especially large park areas, are afforded by adjoining communities. An average of 14.3 per cent. was set aside for such purposes in the above mentioned Emergency Fleet Corporation towns, while about 9 per cent. was reserved in the towns laid out by the United States Housing Corporation. It will generally be found advisable to set aside from eight to twelve per cent. of the total area for parks, open spaces, playgrounds and similar purposes. The land devoted to these purposes should not be considered as a loss of saleable property. This is particularly true, when land unsuitable for building purposes is taken, but in any event, this cost is often more than compensated for by the enhancement in value of the adjacent property and by better living conditions.

After all deductions have been made and the unsaleable portion excluded, from 60 to 65 per cent. of the original area of the tract will constitute the saleable lot area for building use. This will indicate, in general terms, the extent to which the acreage cost will have to be increased to cover the net cost of the land when subdivided into building lots.

Densities.—The number of dwellings per acre, or the building density, is of general interest, as its shows the degree to which the property can be occupied and affords a common basis of comparison. The number of houses per acre is therefore the measurement of the saturation of the plan and also an index of housing conditions. This is best expressed as the number of families housed per gross acre, including the street area, but excluding parks and open spaces. In any particular case, the greater the number of families housed per acre, the less the cost per unit will result from the plan. But a high density, brought about by crowding a large number of families on small lots with narrow streets and lack of open spaces, is poor economy. It leads to undesirable living conditions, the correction or prevention of which is the object of industrial housing and a necessity of our industrial system.

An allotment of less than six families per gross acre, unless the topography is unusually difficult, or an especially expensive development is planned, will generally indicate a wasteful subdivision of the land and a lot size in excess of ordinary requirements. On the other hand, a compactness of over twelve families per gross acre, unless some are housed in rows or apart-

ments, will indicate too intensive use of the land and unfavorable conditions, on account of insufficient light, air and open space.

Density will be influenced by the type and grouping of the houses, the width of the street, and the space allowed for front yard, back yard, and between houses, rows or groups of buildings. A comparison of building densities will indicate the real situation only in a general way, as the disposition of the open space provided and the degree in which it is useful is as important as the amount. Detached houses, placed too close together, may afford a greater amount of open space than row houses, but the side yard space may not be useful in adding to the convenience and in providing necessary light and air,—in fact it may be detrimental.

When the cost of land is high, the number of families housed per acre must be increased, and this can best be done by building row houses, apartments, or two or four-family flat houses, rather than by crowding detached or semi-detached houses upon small lots. Group or row houses may frequently present developments equally as attractive as single or twin houses, as shown in Chapter X.

Residential Districts.—*Dimensions of Blocks.*—The shape and dimensions of residential blocks will depend partly on the influence exerted by topography and traffic requirements upon street locations and partly upon the depth which is best suited or required for the houses and yards. It is therefore essential, in laying out streets and thus fixing the shape, length and depth of the blocks, that they be located in such manner that the block can be subdivided into the proper size lots without waste of land. Unless there is an important reason, such as allotment gardens or playgrounds in the interior of the block, the depth of the block should be that required by the normal depth of the lots, with an allowance for an alley or easement.

The principal dimension, or length of the block, will then be on the main street and, if advantage of the topography is taken, the most favorable and economic locations for buildings will be afforded. In this way, the necessity for building on the cross streets, which will be undesirable and expensive if their grades are excessive, will be avoided and the cost of utilities will be reduced. The layout of Buckman Village (see Fig. 1) is a good example of this arrangement.

The length of the block will be determined by the frequency

BLOCK PLAN

Fig. 1.—Plan of the Buckman Village Project of the Emergency Fleet Corporation at Chester, Pa.

with which cross streets must be located, in conformity with the traffic or topographical requirements. The minimum and maximum lengths will be regulated by economical considerations and by that of convenience of access. A block length of from 600 to 800 feet will be found desirable, when topographic conditions permit. If the blocks are shorter, the area of the land taken for street purposes, and hence the cost of lots, will be increased, as will be the cost of street improvements and utility installations. If the blocks are too long, access from one main street to another becomes inconvenient and the street system will fail in one of its main requisites, that of affording reasonably good and convenient access to and from the houses.

When long blocks are used of necessity, as in hillside locations, where cross streets cannot be provided at sufficient intervals on account of topographical difficulties and the cost of improvements, the situation may in part be relieved, as far as pedestrians are concerned, by providing cross walks, with flights of steps where necessary, leading across the block from one street to the other. An example of this solution is shown in the plan of Loveland Farms, Fig. 2.

There is a further objection to abnormally long blocks, in that the appearance is likely to become monotonous, particularly if the streets are straight, and the houses are small and located close to the street line. Cross streets, particularly where the intersections are carefully planned, both with regard to the streets themselves and to the grouping of the houses at the intersections, add interest and variety and hence enhance the attractiveness. This will be observable in the illustration (see Fig. 43) of the Yorkship Village project built by the Emergency Fleet Corporation at Camden, N. J. Attractive results were obtained by providing a small park space at an intersection and by effective grouping of the buildings which are of the row type.

The length of the block, as well as the size and shape of the lots, should be adapted to the character of the residential district. Where the building density is low, as it will be in the better class residential districts, the block lengths may be increased with less likelihood of congestion and inconvenience.

In districting residence areas in accordance with the grades of houses, three general types will be considered:

(*a*) The more expensive detached and semi-detached houses, usually occupied by the salaried employees and the higher paid skilled

Fig. 2.—Plan of the Loveland Farms Development of the Buckeye Land Company (Youngstown Sheet & Tube Company) at Youngstown, Ohio, illustrating the development of a hillside site with contour streets.

mechanics and clerical force, which will generally require larger lots than the other types.

(*b*) Two and four-family houses and the better class of row houses, where the requirements of the prospective occupants and the anticipated returns will warrant a lot somewhat in excess of the minimum.

(*c*) Row and group houses, where compactness is desirable, in order to reduce the cost of land and improvements.

There may be a further subdivision of the area according to the proposed disposition of the property. For instance it may be found desirable to group together houses to be sold, similarly those to be rented and again those to be handled upon a coöperative plan. It may further be desirable to segregate hotels, boarding houses and apartments.

Residence Lots.—The residential lot is the unit of the town plan, and much depends, both as to the effectiveness of housing and the living conditions which will be established, upon providing building lots of suitable size and shape. Bad housing has been due frequently to wasteful use of land in the original subdivision of the property, which has laid a heavy burden of increased cost upon the development.

If the lots are too deep, the property at the rear is wasted and there is a natural tendency to make the lots narrow and to fail to provide sufficient space between houses, thus preventing proper living conditions. On the other hand, if the lots are of insufficient depth, the frontage must be necessarily increased, and this, as will be hereafter demonstrated, will greatly increase the cost of street improvements and utility installation.

The size and proportions of the lot will depend upon a number of factors but should meet certain minimum conditions. The general requirements should be studied and decided upon before the street layout is made; and the subdivision of the property in the block should conform thereto as closely as topography and other factors influencing the location of streets will permit. The dimensions will be affected by the following:

(*a*) The cost of land.

(*b*) The type and dimensions of the house, the location of the house on the lot, and the grouping of the house units.

(*c*) The required set-back in the front and the distance back of the houses, to answer the requirements of light, air and open space.

(*d*) The required clearance between the sides of houses or the ends of rows of houses.

(e) Rear yard requirements for household purposes, for kitchen gardens and for garages.

(f) The cost of street improvements and utilities.

(g) The cost of lot improvements, such as grading, house walks, planting, fences and hedges.

Cost of Land.—The influence of the cost of land upon the size of lot, and its relation to the housing problem has hitherto been mentioned, and attention called to the relation between the gross and the net saleable acreage. Even where land in acreage is comparatively cheap, much of it may be unsuitable for building, on account of soil or foundation conditions, or by reason of topography. After deductions have been made for the street area, open spaces, and for special purposes, the saleable portion will be considerably less than the general average of 60 per cent. of the gross area. This condition will increase the cost of the usable land.

The Sun Village development of the Emergency Fleet Corporation was located on expensive land within the City of Chester and adjoining the built-up section. Although nearly twenty-two families were housed per net acre of block area (exclusive of all streets and open spaces and undeveloped territory included with the tract), the number of families housed per gross area of the developed tract was about twelve families per acre. About 86 per cent. of the dwellings were of the row type, the balance being semi-detached houses. Although the individual lots generally have 20 feet frontage and 75 feet depth, or an area of about 1500 square feet, the actual average area of the lots, due to loss of land chiefly on account of topographical reasons, is in excess of 2,000 square feet. It is evident, therefore, that topographical features frequently render it impossible to develop the building intensity of the standard block.

Where land values are high, the type and dimensions of the house will necessarily have to be subordinated to the economic size and dimensions of the lot. This will ordinarily lead to the adoption of row houses built on comparatively shallow lots. The appearance of overcrowding will be avoided by providing streets of ample width, and by allowing a moderate set-back from the street line to the house front.

The effects of the size of the lot on saleability must fully be taken into account. Preferences and requirements in regard to size of lots vary widely, and are largely dependent on local custom

and the habits of different classes. If the lots are smaller than the usual custom of the locality, the full value of the improved property may not be realized. The size of the lot must therefore be adjusted to conform to the purchasing power and the preferences of the people for whom homes are built.

Requirements of House.—The type and character of the house, particularly the number, size and arrangement of the rooms, will to a great extent determine the size and proportions of the lot. These must be fixed to meet the requirements of frontage and depth of the building in such manner as to provide sufficient open spaces about the building.

Row dwellings will require from 16 to 20 feet, semi-detached dwellings from 20 to 25 feet and detached dwellings from 25 to 30 feet of house frontage.

Requirements of Light, Air and Access.—Reasonably good housing standards command the observance of the following minimum requirements:

The area of the lot in no event should be less than 1,000 square feet, and should preferably be at least 1,500 square feet. The distance between houses should not be less than 16 feet for two-story dwellings, and it is preferable to make the side yard space at least 20 feet. For higher buildings, this distance should be proportionally increased. The foregoing minimum spacings would apply also to the distance between the ends of row houses, although 20 or 25 feet is preferable in such cases.

The distance between fronts of houses should not be less than 50 feet, and 60 feet is preferable. There should be a space in the rear of at least 50 feet between houses. The foregoing distances should be increased if the dwellings are to be of more than two stories. If garages be used the depth of rear yards should be not less than 35 to 40 feet. A set-back from the street line to the fronts of the houses of 10 to 20 feet is generally desirable, as it increases the distance between the fronts of the houses, affords room for porches, adds to privacy and provides desirable open space.

Average practice in planning industrial residential developments is in the direction of moderately shallow lots; street widths of 50 feet, set-back ranging from 10 to 15 feet, with the minor cross streets 40 feet in width. With 20-foot fronts, this will allow a building density of about 12 families per gross acre, including the street and sidewalk area, but not including allow-

ances for parks or special purposes. If further economy in the use of land is necessary, it should be obtained by decreasing the frontage or by building two-family or four-family flats.

In determining the amount of set-back, the width of the street and that of the planting space in the street area should be taken into account. Where the houses are to be rented and the manners and customs of the prospective tenant do not warrant the expectations that they will maintain attractive yards, consideration should be given to increasing the planting space in the streets, and decreasing the set-back to the minimum required for the front porch. By this means control over street appearance may be maintained.

Lot Improvements.—The various items required in the improvement of the lot, including grading, seeding, planting and fences or hedges, are all related to the size of the lot. The cost of lot improvements will be high where the topography is broken, and considerable grading is required, especially where slopes must be terraced, retaining walls built, or filling of low land is required.

Under some conditions the aggregate cost of these items may well have an influence on the size of the lots to be provided. A decision must also be reached regarding the provision of rear yard gardens or allotment gardens. Where kitchen gardens are provided, they should be of moderate size and may range from 500 to 1000 square feet in area, unless the land is unusually steep or cannot be used to advantage for more essential purposes.

Manufacturing Districts.—The manufacturing or industrial district will be located on the most level ground available and in proximity to the existing or projected railroad and transportation lines. Where there is latitude in choice, consideration should be given to the direction of the prevailing winds, in order to minimize the smoke nuisance. Such districts may in certain cases, be divided or zoned into light and heavy manufacturing; objectionable trades or industries being thus restricted to certain areas.

While a definite separation is desired between the residential and the industrial or manufacturing districts, this result should not be obtained at the expense of convenience of access to and from the homes of the workmen. A water course, a wooded park, a special street, a railroad, or other feature of the plan may form the line of separation.

In planning the village of East Valley Forge (See Fig. 4) a 30-foot drive was provided along the boundary of the area set aside for manufacturing purposes. This street has a sidewalk on but one side, and the adjoining property is so subdivided that only the rear yards of dwellings front thereon. The plan of the town of Ojibway provides for a business street one hundred feet in width separating the steel plant from the town (see Fig. 3).

In large communities, it may be necessary to zone or subdivide the commercial area into wholesale and retail, or warehouse and small store district.

Commercial Districts.—The commercial or business district will ordinarily be located with reference first to the projected system of arterial streets; second, to accessibility to the residential district; and third, to the movement of traffic, from the manufacturing plants, and adjoining communities. Due regard must also be given to the topography, which affects the grades of streets, and the cost of the erection of buildings. Where railroad sidings can be located within easy hauling distance of the commercial district, the cost of handling merchandise will be a minimum. It may even be feasible, if grade crossings and interference with the street system can be avoided, to locate a siding directly in the rear of the business properties, and thus eliminate truck hauling entirely.

The required area for the commercial district can be approximated on the assumption that about one acre will be required for stores and business purposes for each 2500 inhabitants. The length of the block in the commercial district should generally be shorter than that recommended for residential blocks. In such districts, a block length of about 400 feet will generally be found to be satisfactory. Short blocks will provide better facilities for traffic and decrease the fire risk. The additional cost will be in part covered by the increased value of corner properties for business purposes. Where there is to be a concentration of large business establishments in the block, the depth of the lots should be such as to make ample provision for a service court in the rear of the buildings, in order to relieve congestion on the streets.

In minor developments, the community or civic center and the business district may be merged, as has often occured in small communities, where the joint country store and the post office

FIG. 3.—Street plan of the Ojibway Project of the Canadian Steel Company, near Windsor, Canada.

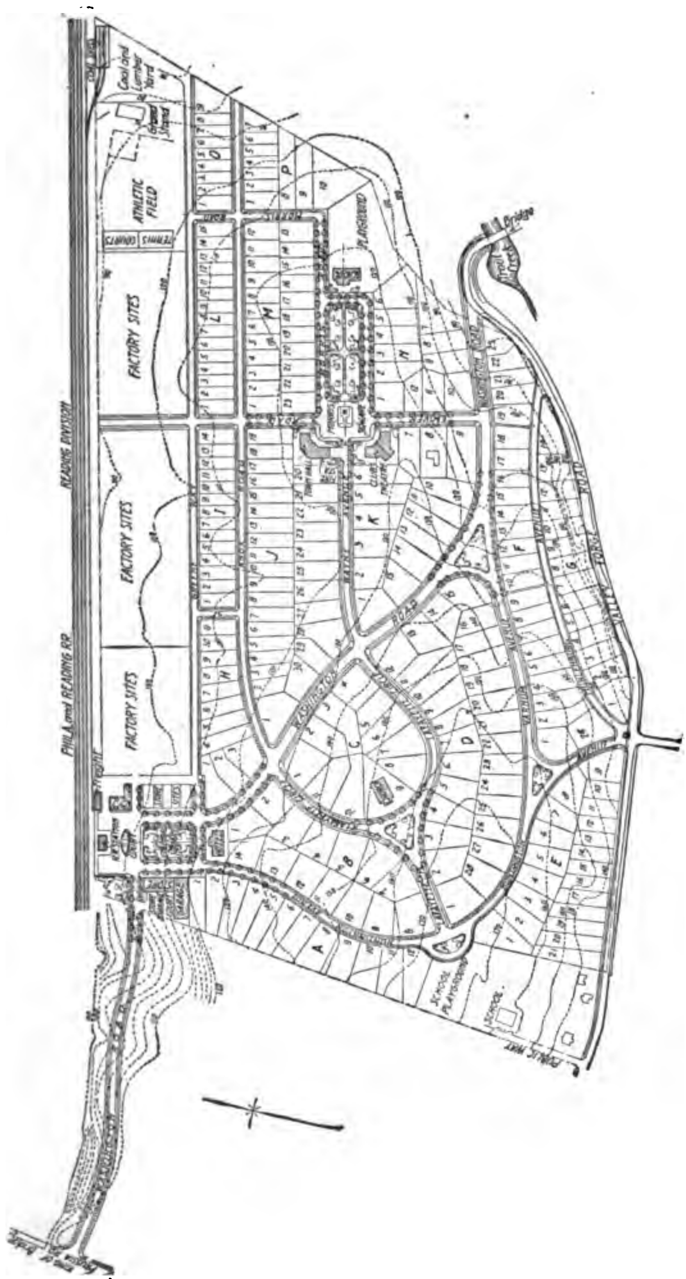

Fig. 4.—Town plan and block subdivision of the new town of East Valley Forge, Pa. A comprehensive plan for a small industrial village, making provision for various grades of dwellings, small commercial and civic centers, and for factory sites.

have formed the nucleus of the growing business and public social life of the residents. In larger towns, a more interesting and attractive plan can be developed by separating these features, but in such cases they should be located with relation to each other, and connected by adequate streets.

As the development of the business section will preferably and generally be left in the hands of individuals, it will follow, rather than be contemporaneous with the development of the remainder of the town. It will be both advantageous and possible for the management of the town to arrange for the use of certain property, subject to restrictions regarding the architectural appearance of the buildings. Furthermore, it will generally be good business to erect some store buildings, possibly in conjunction with apartments, for rental, with the plan of later selling the properties after the business concerns have become established. In such ways the development of the town can be, in a measure,

TABLE. 9.—LIST OF KIND AND NUMBER OF BUSINESS ENTERPRISES IN AVERAGE COMMUNITY

Kind of Enterprise	Number
Bakeries	2
Barber shops	4
Boot & shoe stores	2
Bowling alleys	1
Butcher market	4
Butter & creamery stores	1
Drug stores	2
Fruit stands	2
Garages (public)	4
General stores (groceries & dry goods)	2
Haberdasheries	2
Hardware stores	1
Hotels	2
Ice cream and confectionery stores	2
Laundries	2
Milliners	2
Printing establishments	2
Refrigerating plant	1
Restaurants	6
Shoe repair shops	4
Stationery stores	1
Tailor shops	2
Undertaking establishments	2

controlled, and at the same time progress in such a way that the buildings will be adapted to enhance the appearance of the ultimate arrangement.

The number and variety of enterprises, which will be required in any community will vary through a wide range, and will depend to a great extent upon the comparative isolation of the town, and its dependence on larger nearby communities. The preceding table gives a list of the kind and probable number of different business enterprises that may well be required in an average community of 10,000 people, assuming that the town is comparatively isolated and inhabitated by people of average purchasing power. Some of the enterprises, as bakeries and grocery stores, may frequently be combined in the same business.

Civic Center.—In order that the town may have a pleasing, convenient and appropriate center for its public activities, it will usually be found desirable, unless the town is exceptionally large, to group public and semi-public buildings together. The elements of this group may well include town hall, post office, central school, library, theatre or public hall, churches, hotels and community club buildings. By assembling these buildings together, or such of them as it is necessary to provide, better architectural treatment can be given, particularly where a suitable site is available. The location, grouping and architecture of the public and semi-public buildings will often largely be the measure of the interest, attractiveness and convenience of the plan.

Where a complete and independent town is to be developed, the civic center may well be separated from the general commercial or store district. However, convenience may require the nearby location of small stores or restaurants to take care of the neighborhood and family demands. The predominating requisites of the commercial district—utility and compactness—are somewhat different from those of the civic center—spaciousness, beauty and convenience—and it will therefore be found difficult to combine the two.

The civic center should be reasonably convenient to most of the residential subdivisions and to the main thoroughfare of the town. The requirements of traffic, particularly directness, are not so important that they cannot be subordinated to a reasonable extent, in order that the natural features of the site may be made available in locating and laying out the center. A park-

way, however, located and planned for pleasure traffic, may be used in connection with the civic center, and the latter made one of the prominent, dominating features of a formally organized plan. If due regard be paid to the topographical requirements, effective landscape and architectural features may be obtained.

It is not necessary, and generally not advisable to locate a main artery, particularly where it carries heavy commercial traffic, passing through a civic or community center. Frequently the civic center is developed about a park or plaza, the open space affording the necessary distance, so desirable for interesting and attractive views. It may be advantageous, where the buildings of the civic center group are located about a square or open space, to utilize a main thoroughfare as one of the sides of the square, or to provide a broad avenue leading from the square to the main thoroughfare.

The civic center should be planned on generous lines, even though not completely developed immediately, and the plans should provide for the requirements of the future as to the size, character, and architectural treatment of the necessary buildings.

Parks and Parkways.—Well designed parks are essential to the town plan. They provide places of recreation; contribute to the beautification of the town; improve living conditions, by affording light, air and open space, and furnish interesting drives for pleasure travel. The cost of land devoted to parks will often to a great extent be met by the increased valuation of the adjoining residential property. If a park system is definitely planned and the properties required are reserved, prior to the development of the surrounding territory, the cost will be moderate and desirable results may be obtained by selecting land properly located with regard to the highway system. Parks must be accessible to the people, or they will not be used, and the park system should therefore be planned with proper relation to the highway system.

For the present purpose, two types of parks will be discussed. The first type consists of urban parks of relatively small area, located within the developed parts of the town, and generally planned in a formal manner and highly improved. The second type consists of natural parks, generally located on the outskirts of the town, with improvements chiefly to provide access and to develop natural beauty and scenic features.

Area Required.—The amount of area devoted to parks will depend upon the cost of the land and the character of the residential districts they are to serve. Where row houses on comparatively small lots predominate, there should be liberal provision for urban parks, in order to provide the necessary open space. Congestion demands parks as a necessity rather than primarily as a means of beautification.

In residential districts of the most expensive type, parks are added for the purpose of beautification and increasing the attractiveness of the district. Very often it is preferable, not only as an economy of construction and maintenance, but also as a desirable effect secured, to reduce the width of the streets and depth of lots and combine the land area saved into small park areas.

An analysis of the areas in the villages, planned by the Fleet Corporation and the United States Housing Corporation indicates 13 per cent. and 10 per cent. respectively, of the developed area, dedicated to school, recreational and community purposes.

The areas set aside for parks and other open spaces should range from 5 to 10 per cent. of the total area. This includes small parks at street intersections and the civic center.

The necessity for the more extensive natural parks, lying beyond the built-up districts, depends very largely upon the size and character of the development and the cost and availability of land. They are not to be regarded as so essential to good living or the well being of the community, as urban parks, open spaces and playgrounds but they are highly desirable as they supplement such features and help to make the town more attractive and increase the feeling of contentment and attachment of the residents to the town and promote health, comfort and pleasure of the people. It is one of the ways of giving character and individuality to a town, without which it may be simply a monotonous place in which to live. Provided roadways be constructed to make the park accessible, rough and broken topography, that would be unsuitable for building purposes, may be utilized to advantage for such natural parks.

Location.—It will generally be advantageous, to industrial communities, to have a number of small urban parks readily accessible to various parts of the town, rather than one large one. While the latter may be more pretentious and more susceptible of improvement, it will not properly serve the needs

of the residents. Natural parks, on the other hand, should be of comparatively large area in one unit. Otherwise the appearance of natural beauty cannot be carried out.

The completely developed plan will ordinarily include the following:

A parked area in connection with, and as part of, the civic or community center;

A small park or square in connection with the commercial or business district; such parks, to be developed primarily to relieve congestion and to provide a breathing space in the busy section of the town;

A park area adjoining the industrial plant, providing land is available, in order to afford convenient separation between the town and the plant and for the use of the employees during the lunch hour; parks of this kind are frequently placed under the direction and control of the plant management;

Local parks in the various residential districts, placed with reference to the main street system and the convenience of the residents;

Small park areas at street intersections, as elements of the landscape treatment and to form islands for the regulation and diversion of the flow of traffic;

Parkways and boulevards, which include wide and specially designed streets, with park areas either at each side or in the center, or both. These will form an integral part of the main highway system and frequently connect the park or plaza of the civic center and some of the playgrounds with a larger park area or other important and prominent points of interest.

The reservation of strips of land along ravines and rivers and of low-lying land along small watercourses for park purposes will often utilize property that is unsuitable or expensive for building purposes, and, at the same time serve, after development, as a natural beauty spot for recreation and public use. High ground, particularly if it overlooks a lake or river or affords a far-reaching view of the surrounding territory, will add much to the attractiveness and the charm of the park. Good examples of the foregoing are the reservation of the bottom land for park purposes in the Buckman Development at Chester, Pa., and the setting aside of a grove of trees on a bluff overlooking the Piscataqua River, in Portsmouth Development, both of the Emergency Fleet Corporation (Fig. 1 and 5).

Improvements.—Improvement of small parks in the interior of a development should be undertaken at the time the houses are erected, in order that the tracts may have a finished appearance

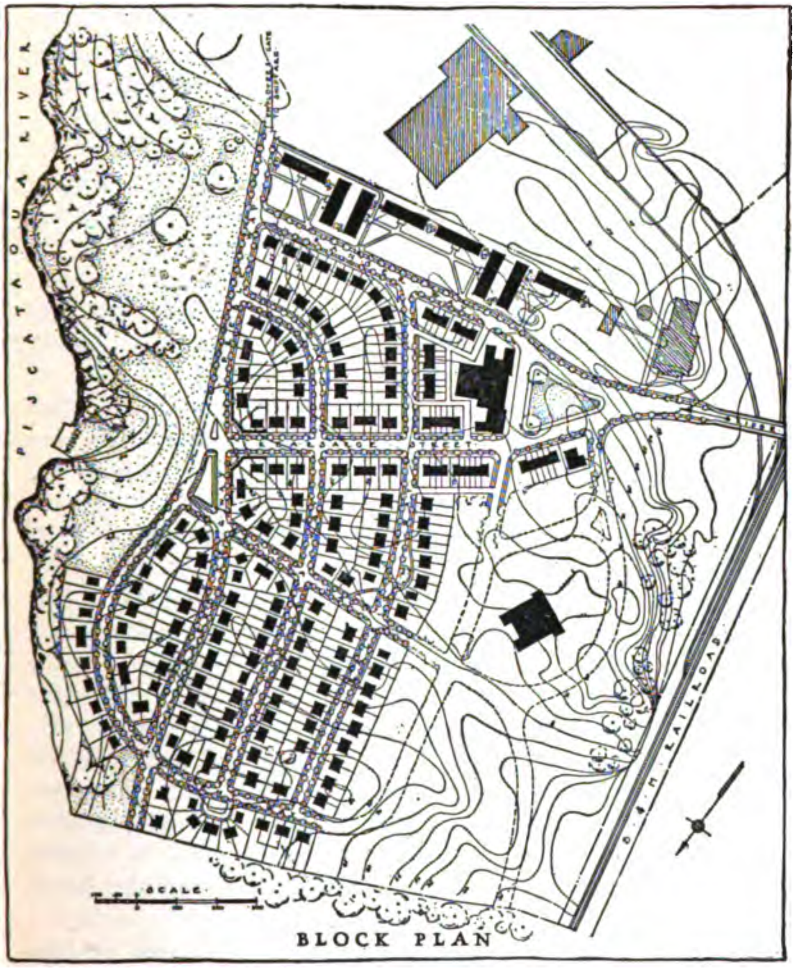

Fig. 5.—Plan of the Atlantic Heights Project of the Emergency Fleet Corporation at Portsmouth, N. H. The area between the Piscataqua River and the village is reserved for park purposes.

and relieve the feeling of newness and incompleteness that detracts from the appearance of a recently built town. A natural park may with advantage be developed gradually.

The drives and walks through parks in the built-up areas of the

town should be laid out, not with the idea of having a symmetrical and interesting plan on paper, as is so often the case; but in such manner as will best serve convenience of traffic, necessary in parks adjoining the business center and in the smaller parks laid out in connection with the arterial street system. Curved walks should be avoided when their use may lead to the inconvenience and annoyance of the busy pedestrian; curvature should therefore be used with moderation unless there is clear necessity by reason of topography.

The drives in natural parks will be used largely for pleasure traffic, and directness, grade and alignment, while they should be kept within reasonable limits, may be subordinated to the requirements of topography, economy of development, or scenic beauty. In developing such larger parks, it is desirable that separate ways be provided for vehicle and pedestrian travel. Care should be exercised to obviate the possibility of accident, particularly in providing clear views at points where pedestrian and vehicle travel cross. Walks and paths should be laid out so that the public may reach various points of interest by following attractive and interesting routes of natural beauty.

Playgrounds.—The necessity for public playgrounds, is no longer a question—the movement has passed beyond the experimental stage. As evidence of their extensive adoption, it was reported that in the summer of 1917, 52 cities had established playground work, this being an increase of 21 per cent. over the number that had done so the previous year. There is further a tendency to adopt year-around operation, with a permanently employed supervising force. During the year ending November, 1917, 481 cities reported a total of 3,944 playgrounds and neighborhood recreation centers, which were operated by regularly employed supervisors and teachers. The method of control varied, about 60 per cent. being operated by the municipality, and the balance by private and civic associations.

Location and Area.—Playgrounds should be located so that children can reach them with a walk of not more than one-half mile. Small open spaces, perhaps in the interior of the block, should be provided for the very small children. Playgrounds should be provided at all schoolhouses, particularly for the primary grades, and should be serviceable not only during the school hours but also at other periods. Particular care should be taken in locating playgrounds, not only that they be readily

accessible to the area which they are to serve, but also that dangerous street and railroad crossings be avoided in reaching them.

The study of the playgrounds of 41 cities, ranging from 60,000 to 1,700,000 inhabitants, indicates a present average provision of one acre of playground for every 4,000 people. It is considered good practice to allow at least two acres of playground for every 1,000 children.

Improvements.—The playground area should be graded, to provide good drainage and to permit full opportunity for play and games. Experience in construction, indicates that the best general plan of grading is to provide a ground slope from a central point, with a grade of about 4 inches per 100 feet. Wading pools and sandboxes should be located so that the ground will drain away from them in every direction.

If the area is sufficient to avoid concentration in play, the surface may be in lawn. A gravel surface will also be found desirable for some areas; tanbark—a layer about two inches in depth—has at times been used and found satisfactory, but requires replacement every two years. The play ground should be fenced, for which purpose wire fencing, with substantial pipe or wooden posts, is recommended. The appearance may be improved by planting a hedge just inside the fence. In addition to the regular playground apparatus, trees, shrubbery, benches, fountains, comfort stations and trash receptacles should be provided.

Apparatus should be arranged at one end of the grounds or about the edges, to provide the largest possible space for unhampered play. It is also well to provide for segregation of children by ages. There should be a periodic and responsible inspection of the equipment and apparatus at frequent intervals in order to avoid the possibility of accident.

Athletic Fields.—Athletic fields, with facilities for baseball, football, tennis and other outdoor sports, are essential for the older boys and men. Plans for large industrial developments generally make adequate provision for such requirements. It is found to be an important factor in building up community spirit and the feeling of attachment by the residents for the town. How far and to what extent the improvements and facilities should be carried by the builder of the project or left to the initiative of the community is a question. Interest may possibly

be stimulated by active participation in providing the facilities, but in any event it will be necessary to reserve a suitable area in the original plans and to do the preliminary work of grading and drainage.

While not absolutely necessary, a recreation building or club-house, provided with showers, lockers and gymnasium apparatus, will be found highly desirable; particularly if the town is of sufficient size, as to warrant the expenditure. Such a feature can be made self-sustaining if properly managed and community interest is aroused.

The location of the athletic field must, of necessity, be largely dictated by topography, as approximately level ground is necessary. While it should be convenient to the town, its removal, within reasonable walking distance, will not be particularly objectionable, if adjacent to a good highway.

Cemeteries.—The reservation of a suitable area of land for development as a cemetery will be necessary where the housing development is separated from other communities. Its development may generally be left to the control of the community, particularly that of the churches, but land should be reserved for the purpose. An attractive site is desirable and the appearance and plan of improvement should, as nearly as possible, resemble those of a park. Places of natural beauty, and groves of trees should not be unnecessarily disturbed.

Cemeteries should be separated from, and preferably not in view of, the residential district. Topographical features or distance may be utilized, and nearby sites, if chosen, may be screened by appropriate fencing and hedge planting.

Location should be carefully chosen. Marshes, swampy ground, or areas of high ground water level are unsuitable; nor should the cemetery be located on ground from which drainage will pass into water courses which may be incidentally used without filtering for drinking water.

The size of the cemetery can be estimated from the anticipated population and the average annual death rate, the general average being about 20 deaths per annum per thousand population. The area should not be entirely laid out for graves, as a portion should be developed for park purposes. Cemeteries should be carefully planned and laid out, with location of drives, lots and areas for individual graves, fully designated to enable the keeping of proper records.

Surface drainage should be provided to prevent erosion. Careful investigation should be made regarding soil and subdrainage conditions and subdrains of broken stone or pipe should be constructed in order to prevent seepage to adjoining areas.

The development of a cemetery will include driveways, preferably on grades not exceeding six per cent., surfaced with materials suitable for light traffic. A water distribution system following the drives will also be required to furnish a supply for the sprinkling of roads, lawns and planting.

THE STREET SYSTEM

The function of the streets is: (1) to provide for through traffic from the town to adjoining communities and centers; (2) to take care of and facilitate inter-communication; (3) to afford access to the buildings; and (4) to provide subdivision of the property into blocks These are the primary uses, but they also serve to afford light and air to the buildings fronting thereon, contribute to attractiveness and order and provide locations for the various systems of utilities.

The street system should therefore serve a number of uses and requirements, which will influence its design in proportion to their relative value and necessities. The classification of kinds and importance of various streets and thoroughfares will be presented later, after considering methods and types of street layouts.

Types of Street Systems.—For ready reference and comparison, a classification of street systems is convenient. Various types of street systems have been devised to answer different requirements and conditions, and very often their use, particularly that of the rectangular system, has been perpetuated largely for reason of convenience and simplicity, and as a matter of habit. The predominating influence leading to the adoption of some systems, has been that of convenient subdivision of property, in others, the requirements of traffic, or economy of construction has governed.

Rectangular or Gridiron.—With a few notable exceptions the rectangular, or gridiron street system has been generally used in the development of American cities. It is composed of streets located parallel and at right angles to each other, or approximately so, except when modifications or deviations are caused by topography, or by natural or artificial barriers.

Its natural and great advantage is that of simplicity and order, particularly where topographical features are not prominent, and the resulting convenience and simplicity of block subdivision. The rectangular blocks can easily be divided into rectangular building lots, and the surveying, recording and description of property is rendered inexpensive and simple.

As affording a system of arterial streets, this type is almost universally open to serious objections and disadvantages. Through traffic cannot adequately be provided for, nor controlled, and inter-communication between districts is necessarily restricted, and made more or less indirect. Traffic cannot be diverted from the residential streets and will often use as thoroughfares, streets not designed or intended for such purpose. The introduction of occasional main or secondary diagonal arterial thoroughfares, while it may minimize in some respects these disadvantages, does not remove some of the inherent objections to this type.

There is a further great objection and inherent disadvantage of the rectangular street system in that, unless the topography be uniform and fairly level, the extent and cost of grading is likely to be excessive. Poor junctions result with connecting streets, and there is danger that the grade of streets, where fills or cuts are necessary, will not fit the adjoining ground and will make the development of the abutting property expensive or perhaps impracticable. Where the topography is rolling or rugged in character the disadvantage of this system is more prominent, and the expense of sewering and draining is greatly increased.

Nevertheless, there has been a persistence in the use of the rectangular system, regardless of topography and the attendant costs of street improvement, installation of utilities and site development. Where the rectangular system is used on fairly level territory, and consequently not subject to the foregoing serious economic drawbacks, its use is often characterized by excessive monotony, particularly where row houses are built in more or less unbroken lines.

It is not to be assumed, however that the rectangular system, cannot be used with advantage, particularly for residential and minor streets, under proper topographical conditions and with occasional modifications. Where used, care must be exercised to avoid monotony by breaking the continuity of the streets, by

open spaces, offsets, or landscape features; by giving variety in the grouping and placement of the houses, by set-backs and by variations in the design and treatment of the street.

Radial or Diagonal.—The radial street system consists of main arteries, which radiate from local points, or "hubs"; thus providing for the requirements of through traffic between various centers and points of importance.

The particular disadvantage, from the standpoint of traffic, is that communication between points, not adjacent to one of the "hubs" or focal points, is likely to be indirect and inconvenient. Rigidly adhered to as a system, particularly where the main arteries are located in straight lines, with little regard for the requirements of topography, it will naturally have the same disadvantages with regard to cost of construction and failure to fit the ground, as pertain to the rectangular system.

In fairly level ground, a system of main arteries on the radial plan, with well arranged secondary arteries, can often be used effectively. The areas between the various radiating arteries will be irregular, often triangular, in shape and can be subdivided with secondary and residential streets upon various plans. The plan of the Ojibway Project (Fig. 3) will illustrate the use of diagonal main thoroughfares with the secondary and residential streets on the rectangular plan.

Formal or Geometrical.—The formal or geometrical plan of streets is one in which symmetry of arrangement and formal design predominate. Very often such a plan will consist of a main axis, possibly a parkway or boulevard along which are located landscape features, prominent groups of buildings, monuments or open spaces; all of which are intended to give a formal landscape effect. There will often be sub-axes located with reference to the main way, providing for the requirements of through traffic and intercommunication and also intended to enhance the landscape effects.

The various residential streets are then laid out to maintain the symmetry and geometry of the plan. Often such a plan, will consist very largely of curvilinear streets and be characterized by the development of the plan around various geometrical forms, such as circles, squares or octagons.

The chief advantages of the formal plan are in attractiveness, interest and order obtained by careful street planning, house grouping, special features and landscape treatment. But formal

appearance, and an over emphasized idea of symmetry in plan, often predominates to such an extent that economy, access and intercommunication are sacrificed without achieving any decided advantage. The formal plan will not, therefore, except to a limited and modified extent, lend itself to the development of the plans for industrial towns.

It is not intended to give the impression that there are not places where the formal plan may well be used, but to advise caution rather than too rigid adherence to formality and symmetry. Waste of frontage, depth, shallow or irregular blocks, poor circulation and intercommunication, are some of the defects often found in formal plans. An overemphasis is further particularly objectionable and futile when the style, size and grouping of the houses is not in keeping with such formality.

In planning large projects, the employment of the formal plan, in designing the important thoroughfares and main features of the town, will not only be possible but advisable when topography permits. The town plan of Yorkship Village, hereafter discussed in some detail, (Fig. 16) is an illustration of a well considered application of the formal plan which was not carried out to an undue extent. It is further to be noted in making plans of this kind, that departure from symmetry in order to meet topographical conditions, while not particularly attractive on the map, can be carried out on the ground without noticeably detracting from appearance.

Irregular or Haphazard.—Where a street system develops in a piecemeal fashion, without intelligent planning or control, as has been the case in so many of our American cities, the resulting street system often can be classified as irregular.

It has all of the faults and disadvantages that obtain with any of the preceding systems; and because of its lack of idea generally has more instances of them. Examples are everywhere present of such lack of care and foresight, and the resultant expenses for correction appear in municipal budgets year after year.

Contour Streets.—Where streets are located with reference to obtaining easy grades, a minimum of cut and fill, and with the idea of fitting the ground so that little lot grading will be required, the streets will roughly parallel the contours of the ground. This may for convenience be described as a contour system of streets.

The grades of main streets will generally be low compared to the natural cross slopes of the surface, and the cross streets, approximately normal to the slope, will have steeper grades. For this reason cross streets cannot be introduced into the plan as frequently as desired, thus making it necessary for local traffic to detour more or less. In so far as residential and particularly the minor residential streets are concerned, the requirements of through traffic do not obtain, and if good access be provided, indirectness, if not excessive, does not detract from the practicability of the plan.

The contour system is, therefore, more applicable in the development of the residential subdistricts of the tract than for the planning of the main system of streets, wherein it will be necessary to consider the requirements of through traffic, especially that of directness. Important connecting thoroughfares, where the contour street system is used quite generally for the residential streets, will not necessarily follow such a plan rigidly. They will deflect therefrom, as required to obtain directness and as permitted by the limits of permissible grades.

As both contour streets and the formal plan will require or employ curvilinear streets, it will be of value to consider the advantages and disadvantages of such streets. Curved contour streets are frequently justified by the topography, as by their use, earthwork and the grade will be reduced. It will be recognized that under some conditions the use of curved streets is dictated irrespective of any disadvantages. However, unless their adoption is warranted, either by physical conditions or great attractiveness, the excessive use of curvilinear streets is questionable and they should not be so employed without due consideration of the extra costs involved. The cost of both the preliminary and construction, field and office engineering work will necessarily be greater than where the rectangular system is used. Such work involves the laying out of the property, locating streets, block subdivisions, line and grade for street improvements, utilities, buildings, lot grading, the preparation of record drawings and the description and recording of the individual lots.

The increased cost of utility construction will be the largest item of expense in building curved streets. It will cost more, particularly if the curves are so sharp that trenching machines cannot be used, to excavate, sheath and shore a trench on a curve

than in a straight line. Sanitary sewers, where the sizes are small and grades low, will be laid on chords, thus increasing the number of manholes required. As a larger part of the continuous street cross-section will thus be occupied, there is greater probability of interference with other substructures. If overhead pole lines are to be located on the streets, sharp curves and angles will require excessive guying.

A reasonable amount of curvature, introduced for specific purposes, will not have the striking effects herein described, or at least such will be comparatively negligible. But the increased cost occasioned by the excessive use of curvilinear streets cannot be ignored, and must be balanced against the saving in street and lot grading, the omission of retaining walls and bridges, the reduction in grade and other advantages.

The plans of Buckman Village, at Chester, Pa., (Fig. 1) built by the Emergency Fleet Corporation, and that of the Loveland Farms Development, at Youngstown, Ohio, built by the Youngstown Sheet & Tube Company, are typical of the extensive employment of contour streets. In the former development, the slopes, although short, are generally uniform, and the blocks are approximately rectangular, so that the system may be classed as rectangular with modifications to conform with the topography. The irregularity of the topography in the case of the Loveland Farms plan, (see Fig. 2) made such an approximately rectangular arrangement impossible, uneconomical and undesirable. Much better results were secured, in obtaining good grades, in low cost of street and lot grading, and also in obtaining a large number of good building lots, than would have been possible had the rectangular system been used.

Rational Layout of Streets.—The street system should be designed to answer its primary and essential requirements as to traffic, access, cost and property subdivision. A rational method of planning is advised, rather than unquestioned adoption of any particular system. The questions of purpose and use should predominate and dictate in working out the plan and its details, and there should be good reason and definite objectives for the designation of each street and each element and feature of the layout. Formality and symmetry should be employed to the extent that the importance of the project and its general scheme warrant, and topographical features permit. Radial streets, connecting the important centers and making due provi-

sion for the requirements of through traffic, should be located with regard to this prime requisite and with only subordinate attention to the size and shape of the intervening tracts.

The system of streets to be adopted need not be of any particular type, but should utilize any of the foregoing systems in whole or in part, to the extent which conditions warrant and which will accomplish the desired results. The plan of arterial highways will necessarily depend upon traffic requirements, and the number and location of important centers and strategic points, so that advice which will be generally applicable cannot be formulated, except in regard to general principles. The location, grades and width of arterial highways should be fixed in conformity with the requirements of through traffic.

In the business or commercial district the rectangular plan of streets, and policy of avoiding curves and steep gradients should generally be followed. The residential streets will be arranged on either the rectangular, the formal or the contour system, in such manner as to conform with the type of development, house building, lot subdivision and topography. In residential districts attractiveness, economy of construction and conformity with lot grades will take precedence over the requirements of traffic.

Classification of Streets.—Streets may be classified with reference to importance and character of use. Such a classification having in mind a completely developed street system, is as follows:

1. Arterial streets, or main thoroughfares, which are essentially through traffic streets.
2. Secondary streets, being important links between arterial streets and forming connections with the various districts or centers.
3. Major and minor residential streets, provided primarily to afford access to the houses and carrying only local traffic.
4. Industrial and business streets.
5. Special streets, such as boulevards, parkways, etc.

In such a classification as the foregoing, the amount of traffic is kept more or less in mind. The use of the several kinds of streets will now be discussed.

Arterial Streets or Main Thoroughfares.—Main or arterial streets must be located and designed with particular reference to their principal function, that of providing as direct, con-

venient and economical facilities for through traffic as the requirements demand and the topographical conditions permit.

Where an arterial street or thoroughfare is not to pass through the project, a primary street should be located with proper relation to the street system and in such manner as to afford a good connection to existing or projected arteries. Where an arterial highway passes through the project, that section within the project should be designed, not only to care for the requirements of through traffic, but also the particular requirements created within the project itself. Particular attention should be given to the frequency and manner of making connections with the street system of the project, to the parking of vehicles along the curb and to other uses required of an urban street.

Streets of this class should be so located that they will connect the various centers as directly as possible. Modifications and deviations from the straight line will necessarily be made, in order to keep cuts and fills within reasonable limits and prevent damage to adjoining properties. If the topography is generally flat or uniform, long tangents may be used; making only such modifications as may be necessary to avoid undesirable subdivision of property. It must be borne in mind, however, in locating traffic thoroughfares that the effect upon the subdivision of property is of relatively minor importance.

Where changes in alignment are necessary, the deflections should be made by means of easy curves, as the flow of traffic will be obstructed if sharp angles must be turned or if vision is lessened by such turns. Many roadways of ample width lose their effectiveness and their capacity, on account of obstructions and delay occasioned by sharp turns and awkward junctions with other streets.

The width of an arterial street should be based upon the estimated volume of future traffic, with suitable provision for local requirements and uses. Streets of this class should not be less than 60 feet in width, which will provide for a roadway width of 36 feet. In large projects, where the arterial street is one of the primary streets of the town it will often be found desirable to increase the width, to 80 or 120 feet.

The distance between property lines, defining the width of the street, should be made ample, even though a comparatively narrow roadway will answer immediate requirements. This is for the reason that this traveled way may be widened, without

incurring excessive property damage or construction cost; thus the elastic street and possible future use is provided. A later widening, involving setting back and changing the property lines, will generally be very costly and difficult to execute.

The grade of arterial streets and of the primary streets of the town should not exceed five per cent., otherwise greatly increased cost will result. The United States Housing Corporation recommended that the grade of main thoroughfares and first-class business streets should not, if possible, exceed three per cent. The Emergency Fleet Corporation indicated a desirable maximum of not over five per cent. for streets of this class. Whatever may be the desired maximum grade, the limitations imposed by topography may make it necessary to adopt gradients considerably in excess of those hitherto recommended. The ruling grades of highways in the vicinity, and particularly that of arterial highways, should be fully considered, and no undue expense or deviation from direct line resorted to in an endeavor to obtain grades less than the limiting grades of connecting highways.

Grade crossings should be avoided, as they are not only a menace to life but they seriously obstruct traffic as well. Even though a grade crossing must be maintained for the present, arterial and main thorough fares should be so located on the plan, that the elimination of such crossings can be subsequently accomplished without undue expense or disturbance of conditions.

Subarterial or Secondary Streets.—Streets which form important traffic links between or to arterial streets are classed as secondary, or subarterial streets. The requirements of these are intermediate between those of arterial and of residential streets. As traffic requirements are not so important, the minimum gradient can be increased but should not exceed eight per cent.

The principal street of the development, if through traffic is not to be provided for, and if the development is of comparatively small size, will fall into the class of secondary streets, although the street in question is the major one in the development itself. The requirements of heavy hauling to and from industrial plants must, however, be taken into account in fixing the grade.

The width of secondary streets, varied to suit requirements, will range from 50 to 80 feet. Secondary thoroughfares should

be planned with some reference to the subdivision of property, particularly to avoid division into awkwardly shaped blocks. Directness, however, should not be unduly sacrificed, although it is not as important as in the case of arterial thoroughfares. Advantage, to a reasonable extent, may be taken of adjusting the location to the topography. Seondary streets should be laid out with the idea of diverting through traffic from residential streets. Commercial traffic and heavy hauling, particularly, should be confined to streets located and built for that purpose.

Residential Streets.—The planning and location of residential streets is closely connected with property subdivision. The principal purpose of such streets is to provide access, vehicu-

FIG. 6.—An interesting street view in the Union Park development of the Emergency Fleet Corporation at Wilmington, Del.; a contour street in the planning of which, care was exercised to preserve the trees.

lar and pedestrian, to and from the houses; and to afford an open space between the houses thus providing light and air. They are to be located and the grades to be fixed in accordance with the foregoing requirements, and in a manner permitting the property abutting thereon to be conveniently and economically developed for residential purposes. Attention must further be given to the appearance and attractiveness which will be obtained when the proper relationship exists between the location, design and treatment of the streets, and the planning, grouping an architectural treatment of the houses.

The relation of the residential streets to the primary and

secondary streets of the town is of great importance. It is desirable, for a number of reasons, so to plan the former and their connections with the secondary and major streets that a free outlet to traffic will be afforded, without attracting through traffic and heavy hauling to the residential streets. This is not to be accomplished by imposing objectionable difficulty in the way, such as excessive grades, narrow widths or poor paving, but by inviting traffic to the main highway, by the superior facilities and convenience offered. Such regulation of traffic can further be effected by making traffic routes through the residential streets relatively indirect when compared with those obtaining on the main highways.

Monotonous continuity is neither necessary nor desirable. Where the rectangular system of streets is laid out, variety and attractiveness should be obtained by the occasional use of curves, open spaces and special treatment of intersections, and by breaking the continuity of the streets in such a manner as to afford attractive vistas and interesting views.

The width of residential streets will vary with the practical requirements. It is related to the minimum desirable distance between the fronts of houses, and with the design of landscape treatment. Widths of 50 and 40 feet are ordinarily used for residential streets and 60 feet in high class developments. When special emphasis is desired, wider streets with central park spaces are used. At times it may be desirable to reduce the cost of grading by the use of hillside streets of narrow widths. Where it is planned to erect houses upon the upper side only, the width may be made even less than 40 feet. Streets of this type with a width of 30 feet, and a sidewalk on the upper side, have given satisfaction.

It is desirable that the grades of residence streets should not exceed twelve per cent., both on account of the increased cost of paving and maintenance on steeper gradients, and of the difficulty and expense of building on the abutting frontage. Although the maximum gradient may be used where necessary, it will be generally desirable to limit the grade to the neighborhood of eight per cent., especially on long slopes.

Business Streets.—Business streets should be located and planned for the particular requirements to which they will be subjected. The following recommendations apply to streets of this character.

The alignment should preferably be straight, as the buildings, facing thereon will ordinarily be solid business blocks abutting on the street line. The grade should preferably not exceed three per cent.

The width must be ample to take care of the requirements of through vehicular, street car and pedestrian traffic, and to permit of vehicles standing at the curb without impeding the movement of traffic. A minimum width of 36 feet of roadway and an overall width of 60 feet is indicated, but this width will be insufficient if the street be characterized as an important thoroughfare. In such cases the requirements of through traffic, convenience and use would indicate a width of at least 80 feet. The width, however, should not exceed 100 feet as excessively wide streets tend to discourage business.

The width of the sidewalk and planting strip should be ample and not less than 12 feet. If there is any concentration of business upon the streets, the planting space between the curb and paved walk should be omitted and the sidewalk extended from the property line to the curb.

Streets with Car Tracks.—When a street or thoroughfare is to be occupied by a street railway line, it will be either a main or secondary traffic thoroughfare and will therefore be planned both to serve the general requirements of such highways and also the particular requirements of the street railway. When a double track is to be laid, the minimum width of streets should be 60 feet, which will allow for a 36-foot roadway. A 54-foot roadway, and a total width of street of 80 feet will be much better, as it affords room for vehicular passage on each side of the tracks with standing room at the curbs.

Parkways and Boulevards.—Parkways and boulevards may be classed as specialized streets. They will be provided primarily to afford attractive and pleasing routes for fast-moving pleasure traffic, and as features in the landscape design. They should be located with proper relation, to points or centers of interest, and should be carefully coördinated with the design of parks, public buildings, the civic center, and other main features of the town plan.

In cases of this kind, there is naturally great variety in methods of treatment and in the factors of the design such as width, arrangement and general plan. They generally provide for street car tracks, if used, in an unpaved and grassed strip either in the center

with a drive on each side, or else at one side, removed from the travelled way; the latter is particularly useful on side hill construction.

Alleys.—Alleys should be provided when necessary to afford access to the rear of row-dwellings, apartments or business blocks. They should, in all cases, be public thoroughfares, at least 12 feet in width, paved for 8 feet; or if two-way traffic be required the minimum width should be 16 feet. Alleys should be located to afford a clear view from both ends, thus facilitating lighting, inspection and policing. Where narrow alleys are provided, change in direction, if required, should be made on easy curves, permitting vehicles to turn without damaging fences and hedges. The erection of board fences or of buildings abutting directly on the alleys should be prohibited by restrictions and by the building code.

There has been much discussion for and against alleys, and there has been a marked tendency in recent years to largely discontinue their establishment wherever possible in municipal and town planning practice. Alleys will generally be necessary as service roads where houses are built in long rows. Their use in other circumstances will depend upon the relative advantages and disadvantages accruing therefrom.

Their principal advantage will be to promote convenient access for the delivery of household supplies, as food stuffs, and coal, and the removal of household waste, as garbage, rubbish and ashes. They may serve to make possible the effective sanitary inspection of rear lots, and the character and habits of the occupants may make alleys desirable for this reason. They may provide access in case of fire, which is an important element if long rows are to be built. The modern demands for space for the automobile garage, even for the smaller homes and all classes of occupants, may make alleys desirable, particularly if the houses are to be sold.

Alleys may often be used to advantage for the location of overhead and underground utilities; and, although easements will serve such purposes as well, public utility companies are often disinclined to locate in the latter, on account of the difficulty of access and their preference for a public highway.

The first objection to alleys is the cost of construction and maintenance. Such improvements as grading, paving, draining

and lighting will appreciably increase the total cost of the project. They will also add to the lot cost where the abutting property has to be graded to the alley, and where fencing on the rear lot line, and a rear house walk, may be required.

The cost of operation embraced in the upkeep and maintenance, is a further item of importance. Alleys must be cleaned with the same care as the streets; they must be lighted and policed; and the pavement must be kept in repair. Undesirable living and sanitary conditions often obtain in alleys of urban districts; this should be kept in mind and avoided by intelligent planning. The cost and disadvantages of alleys are such that it

FIG. 7.—A concrete service alley in the Dundalk Project of the Emergency Fleet Corporation, near Baltimore, Md.

may be wise to consider building semi-detached, or small groups of houses, and providing passages between the groups or rows, rather than constructing alleys.

The author made an estimate in 1913 of the cost of constructing alleys for a large project for five thousand houses. The results of this study showed that the additional net cost for alleys twelve feet wide was about $200,000 or $40.00 per lot. The estimated increase in annual maintenance expense per lot was $5.30. The increase in house rental to cover the cost of constructing and maintaining alleys, according to the above figures, would be about 44 cents per month. Present day costs

of construction would greatly increase the foregoing. In this particular instance, the recommendation that alleys be omitted from the plan was made and adopted.

Details of Street Design.—*Width of Roadway.*—The width of roadway must be fixed to accommodate the traffic, to permit the temporary parking of vehicles along the curb and to permit the turning of vehicles from the street into private driveways without unduly interfering with the movement of traffic. The width of the street, which includes, in addition to the road-

Fig. 8.—Rear yards of row houses of the Sun Hill Project of the Emergency Fleet Corporation at Chester, Pa. Access to the rear is gained by the concrete walk, located on an easement, and which has a dished cross-section and serves to facilitate surface drainage.

way, the sidewalks and planting strips, should be planned to take care of the future requirements, rather than those of the present.

It will be unnecessary and uneconomical to make the present roadway of greater width than the traffic requirements will demand at the end of the life of the initial surfacing. This suggests the so-called "elastic street," which contemplates the laying down of pavements adequate for present requirements in such way that the roadway can later be widened, when resurfaced, by moving back the curbs.

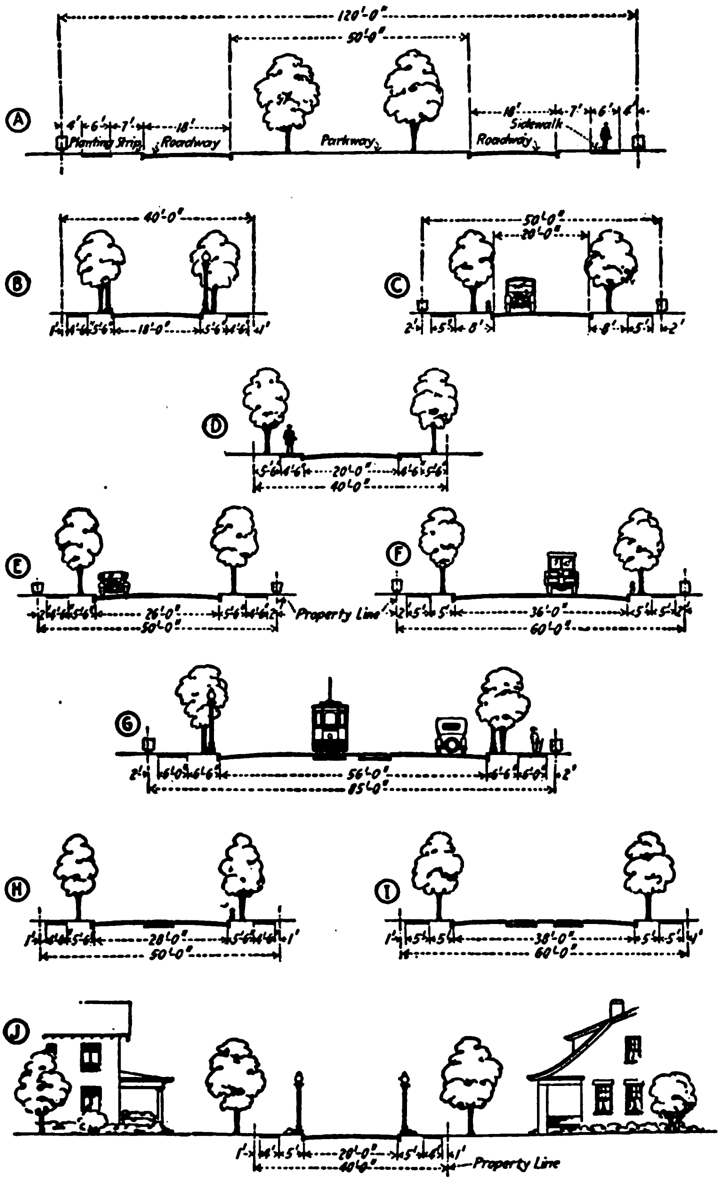

FIG. 9.—*Typical and suggested examples in street subdivision.* (A) A parkway in Yorkship Village. (B) 40-foot street with 18-foot roadway. (C) 50-foot street with 20-foot roadway. (D) 40-foot street with 20-foot roadway. (E) 50-foot street with 26-foot roadway. (F) 60-foot street with 36-foot roadway. (G) 85-foot street with 56-foot roadway designed for four lines of vehicular traffic and two street car tracks. (H) 50-foot street with 28-foot roadway and single track. (I) 60-foot street with double track. (J) Alternative design of 40-foot street with tree line set back of street line.

Detail recommendations on the subject of widths is presented in Chapter V.

Sidewalks.—The width of the paved sidewalk should be fixed to meet the requirements of pedestrian travel. It will range from a minimum of four feet to six feet for residential streets, and from eight to twelve feet in business districts. Such width of sidewalk should be paved as early as the requirements appear to make necessary. The paved width may later be increased with little difficulty, provided the distance from the curb line to the property line has been made of adequate width.

The sidewalk space includes not only the paved sidewalks, but the planting strip, and the space reserved, if any, to permit of future roadway widening. The ordinary practice is to allow a narrow strip, generally two feet in width, between the property line and the edge of the sidewalk, and a planting strip, between the sidewalk and the curb. This main planting strip should be at least five feet wide, in order to give requisite space for the planting of trees, and to discourage pedestrians from encroaching upon it by giving it sufficient emphasis. A 40-foot street, with a 20-foot roadway, will allow for two 10-foot side widths, each width providing space for a one-foot strip between the property line and sidewalk, a 4-foot paved sidewalk, and a 5-foot planting strip. If there is occasion to make some of the minor streets less than 40 feet in width, the planting strip must be decreased, and it may be advisable to lay the paved sidewalk directly against the curb; thus placing the planting strip between the inner edge of the sidewalk and the property line. This plan was followed with pleasing effect in improving some of the minor streets of the Dundalk development at St. Helena, Md. built by the Emergency Fleet Corporation.

Court Streets.—Dead-end streets are to be avoided, as objectionable from the standpoint of traffic requirements and particularly from the standpoint of fire protection and policing. Desire for variety and special grouping for expensive residences or apartments and where the contour of the land dictates, may, however, make it advisable to develop part of the tract with court streets, by extending a minor residential street from the main street and providing an ample circular turn at the extremity. Such streets or courts have been frequently used to advantage in the development of high-class property, and are of value in that they add to attractiveness and individuality.

Court streets may further be used to develop those portions of the tract, where it is difficult or impossible to locate a through street; and can particularly be used advantageously in subdivisions where the topography is broken and steep slopes predominate. This idea was employed to a considerable extent

Fig. 10.—Typical study of planting for housing development; proposed planting for the housing project of the Emergency Fleet Corporation at Newburgh, N. Y.

in the subdivision of the Loveland Farms project (See Fig. 2) and made possible a far more economical subdivision of the property, particularly in the case of deep and irregular blocks, than would have been the case if through streets had been located.

Orientation.—As it is desirable that each room of a dwelling should receive direct sunlight during some part of the day, the

question of exposure should be carefully considered where there is choice in the orientation of the streets, particularly in northern climates. Streets should be located in such a way as to give the largest amount of building frontage having good exposure, especially in case row houses are to be built.

If topographical or other conditions require that some of the building streets extend east and west, conditions can be greatly improved by suitable lot subdivision. Preference should be given to building detached houses, with side windows in the rooms having northerly exposure, rather than group or row houses.

Intersections.—Intersections and junctions of important traffic thoroughfares must be planned in such a manner that the movement of traffic will not be interrupted nor collisions occur. This will generally involve, with narrow roadways, the enlargement of the intersection, the rounding off of the corners, or the occasional employment of central park spaces of circular or of curved form. The latter should be designed with care, in order to facilitate and direct rather than obstruct, traffic movement, and should be planned to favor traffic on the more important street. The grades of important intersections should also be carefully designed, those of the more important highways being given the preference.

It is desirable to reduce the number of intersections of minor and arterial streets to a minimum consistent with good circulation and access, so that the movement of high speed traffic on the thoroughfare will not be subject to frequent interruptions. Suggested designs for typical intersection problems are illustrated in Fig. 11.

The intersections of residential streets, insofar as traffic is concerned, do not ordinarily require any special study, except to insure that good platform grades are used, and that the corners are eased off with curves of sufficient radius to permit the easy turning of vehicles. Such intersections, however, may be utilized in developing the landscape scheme, by employing street offsets, central parked areas, and special designs of interest, individuality and attractiveness.

Profile and Grade.—The profile of the street and its elevation relative to that of the finished surface and adjoining lots and floor levels of buildings is of great practical importance and also affects appearance and attractiveness. For the sake of appear-

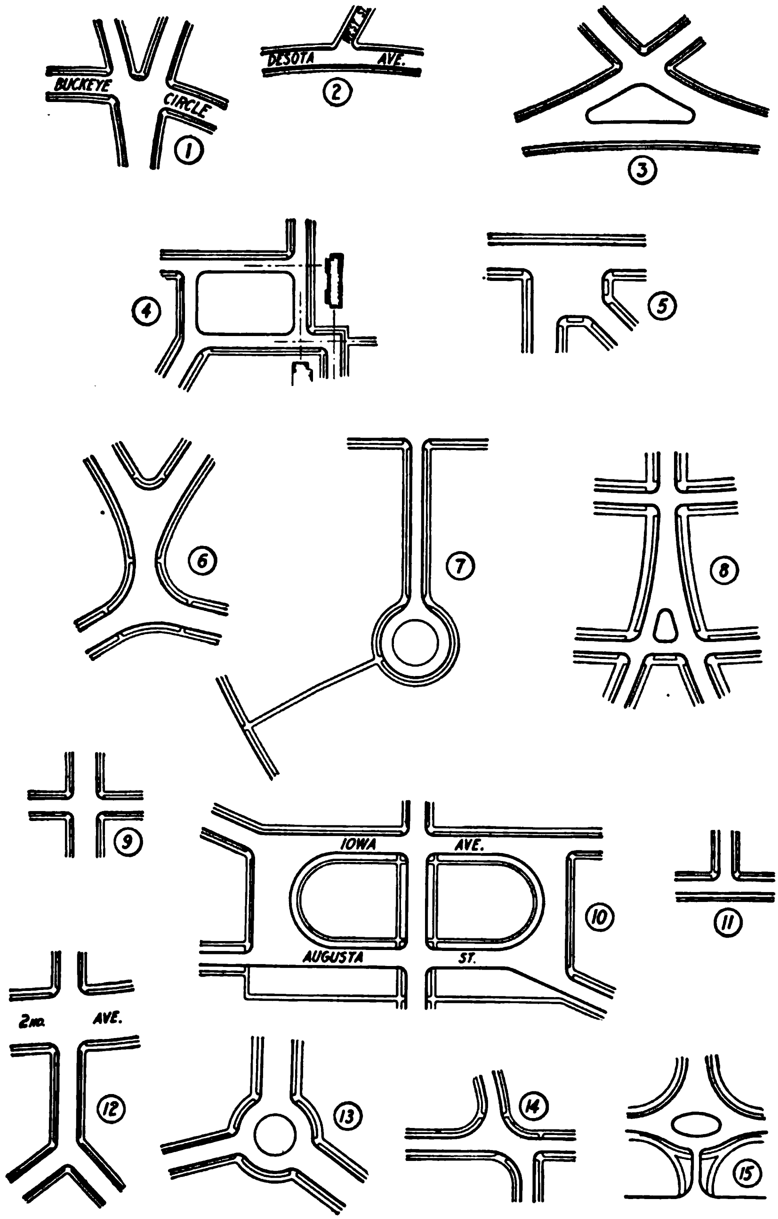

FIG. 11.—*Typical street intersections:* (1) An enlargement at a five-way intersection. (2) Rounding of radius at acute intersection. (3) Typical parked area or island, at intersection. (4) A small parked square in a residential plan. (5,6) Intersections designed to facilitate traffic movement. (7) A court street

ance, the first floor level of the buildings should be at least two feet above the street, depending, however, upon the set-back and the topography. In some instances down-hill depressions are used, and need special treatment. The requirements of lot and block drainage must be considered, together with those of gutter capacity and traffic as outlined in a following chapter. Such determinations should be made at the time of preparing the design and fixing the grades of houses, walks and lots, in order to insure suitable drainage and promote economy in construction.

FIG. 12.—Street view in Buckman Village, Chester, Pa.

The curb grades must be fixed so that sufficient fall will be provided to drain the sidewalk and planting strip, and the finished surface of the adjoining lots. This will require slopes of not less than one-quarter inch per foot for paved sidewalk surfaces, and from three-eights to one-half inch per foot for lawns. It is advisable, topography and cost permitting, to have the front lawn drain to the sidewalk. The manner in which the drainage

with turning circle and connecting walk. (8) An intersection design from York ship Village. (9) Conventional four-way rectangular intersection. (10) Donley Square in the Lorain Project of the Emergency Fleet Corporation. (11) Usual three-way intersection. (12) Intersection designed to prevent traffic congestion at intersection of minor streets with main thoroughfare. (13) A circular or gyratory intersection of three streets. (14) An informal design of an offset intersection with easy curves. (15) An intersection park in a minor residential street.

of the side and rear yard can best and most economically be effected will depend upon the topography and the comparative amount of grading required. In fact, the whole grading problem, including street improvements, lot grading and cellar excavation must be considered as a single problem.

The amount of cutting and filling that can be done on street and lot improvement will depend, to a considerable extent, upon the surplus or deficiency of material that will be available. If there is a deficiency in filling material, additional cutting on the streets, in order to improve grades or appearance, or excavation of lots which are above grade, will be indicated. On the other hand, if there is a surplus of excavation, the material may be used to advantage in filling up low areas. The most economi-

Fig. 13.—A street in the Dundalk Housing Project, illustrating effect of curvature and wide planting strips.

cal results will be obtained when the necessary cutting and filling balance over short lengths of haul.

With regard to the street profile, it is important that changes in slope should be made by easy vertical curves, rather than by abrupt changes. Appearance, particularly the view obtained by looking along the street, must be kept in mind, and it is important to remember that a too frequent repetition of vertical curves on straight streets, giving the effect of an undulating surface, is particularly displeasing. Sumps, or low places, without surface outlet for the drainage, should be avoided if possible, to obviate possibility of flooding.

Easements.—Easements may be reserved, extending through the block along the rear lot line; for the specific purpose of erect-

ing or constructing, using and maintaining underground utilities and pole lines. The rear lot lines of the adjoining property will extend to the center of the easement, and the title of the land covered by easement will be vested in the abutting owners. The provisions of the deeds, however, should restrict the property owners from erecting buildings upon the easement, and will give the owner or builder of the development, or the municipality, the right to construct, or to give official authorization to a corporation or individual to enter upon and construct or erect the utilities. Thereafter the right will exist to use, maintain and replace the same, or the right may be given directly to a public utility company or companies, as the case may be. The rights and restrictions of the easement should be definitely shown upon the property map and should be fully described in the deeds.

Easements should be of ample width, depending on the space required by the utility, to enable substructures to be repaired and maintained, without encroaching upon the unrestricted private property adjoining, and should be located to conform as well as possible to the requirements of alignment of the various utilities. Sharp turns and irregular alignment will be particularly objectionable, in the case of sewers or pole lines, and therefore should be avoided.

Location of Street Railways.—Ordinarily street railways will be located in the center of the paved roadway. Where a wide street, however, is planned and warranted, the track may be placed in a special right of way, with a small planting strip between the tracks and the parkway curbing. Driveways of the required width will then be located, one on each side of the track with cross-overs at important street intersections. It will be preferable for the municipality, or the builder of the project, to retain ownership of the track area, unless the railway company engages to maintain the same. In the latter case, the necessary crossings over the right of way should be reserved as public highways.

It may also be advisable to consider an alternative location of placing the track on one side of the street between the curb and the sidewalk, but this is possible only when a wide street is planned. There are many advantages accruing if the street car track can be located away from the paved roadway. Neither vehicular nor street railway traffic will be obstructed by interference, and the cost of the maintenance of the pavement will be

materially lessened. Typical and suggestive cross-sections of streets carrying car tracks are shown in Fig. 9.

Utility Location a Factor.—The close relationship which exists between the location, design and cost of the utility systems and the development of the town plan is a most important consider-tion that must not be forgotten if maximum economy is to be obtained. An important illustration of this relationship will hereafter be discussed, showing the relation of frontage and depth of lots to the cost of utilities and street improvements. It will be evident, when the requirements of the various utilities are considered in detail, neglecting the variations caused by

Fig. 14.—A street in the Sun Hill Project of the Emergency Fleet Corporation.

topographical and soil conditions, that there will be a great difference in the cost of development and provision of utilities for different town layouts of the same tract of land.

Drainage and sewerage can be effected far more economically if reasonable consideration is given to the requirements of lines and grades. The location of a street in a valley in such a manner that it unnecessarily crosses the drainage line, and introduces rising grades, may require excessively deep cutting for the sewer. Again, it may be possible to locate a cross street on a line which will serve not only the requirements of traffic and access, but also afford the best available location for the sewers or drains. If this is not done, it may be necessary to undergo extra cost to

lay the sewers or drains on private easements, or to follow an indirect route, both of which are objectionable for many reasons.

The location of overhead pole lines on easements or on alleys extending through the blocks, and the relationship with house location as brought out in Chapter IX, is a most important factor in regard to the installation of these utilities. There is a growing realization of the fact that a large part of pavement maintenance is chargeable to the utilities located under the street pavements. Accordingly, there is a tendency to remove underground structures from beneath the paved roadway to the greatest possible extent.

Further discussion of recommended practice in the location of utilities and substructures, and the relation to street location and kind of surfacing will be presented in other chapters.

Cost of Utilities Affected by Lot Sizes.—There is a direct relation between the size and dimensions of the lot and the cost of street improvements and utilities, the full importance of which is often not fully realized. The relative effect of increasing the frontage and depth of lots on cost of improvements and utilities should be taken into account in determining the location and placement of the house on the lot. The following, presented by the author at the Ottawa meeting of the American City Planning Institute, December, 1919, is a brief discussion of the factors concerned, illustrated by an assumed concrete example:—

"There are many elements, even of street improvements and utilities, that in no way affect the size of the lot, or are affected by the size of the lot. For example, there might be mentioned:

"*First.*—Certain portions of the public utilities not commonly located in streets, such as the water supply, pumping station and filtration plant; sewage treatment and disposal works; the power plant to generate electricity; the steam plant, in the event that the houses are to be heated from a central heating station; and in some cases a gas plant.

"*Second.*—Various trunk supply lines which lead from their respective plants to the town site. These include the water supply trunk lines; gas and steam trunk lines; electrical transmission lines; and the sewer and storm drain outfalls.

"*Third.*—Those street improvements and utilities that lie directly in front of the house and that parallel the depth of the house. These portions of the utilities and street improvements are really more affected by the size and arrangement of the house than by the dimensions of the lot. Likewise, there are certain elements of the house connections which are not affected by the size of the lot; for example, the house meters

and the portion of the house services that lies within the street. In other words, only that portion of the house connection that lies within the yard is affected by the size of the lot.

"*Fourth.*—The street improvements and utilities which lie within the street intersection are not directly affected by the size of the lot, but are primarily a function of the block sub-division."

As a result of the above processes of elimination, it is possible to make a clear, well-defined statement of those elements which directly affect the size and depth of lots.

1. They include the street improvements and utilities located directly in front of the space lying between the houses.
2. They include the street improvements and utilities located on the minor streets and lying opposite the space occupied by the front yards and by the rear yards.
3. They include those portions of the house service connections which are located in the front yards and in the rear yards.

Figures shown in Table 10 are the cost per lineal front foot of side yard and per lineal foot of depth of front and rear yards. Cost per lineal foot of lot frontage and depth would be greater, as the cost of house meters, shut-off valves, etc., would be included in the latter cost. These are based upon the same data and assumed town site as used in the preparation of Table 1.

TABLE 10.—COST OF UTILITIES AND STREET IMPROVEMENTS PARALLEL TO FRONT AND SIDE YARD SPACES

Items	Chargeable to 20 feet of side yard	Chargeable to 15 feet of front yard	Chargeable to 59 feet of rear yard	Per lin. foot of side yard	Per lin. foot front yard	Per lin. foot rear yarb
Street improvements (with land).	$117.67	$10.25	$40.30	$5.88	$0.68	$0.68
Water system	18.00	2.68	10.54	0.90	0.18	0.18
Electrical system	0.40	0.00	0.00	0.02	0.00	0.00
Gas system	15.00	1.61	6.32	0.75	0.11	0.11
Sanitary sewers	19.00	0.94	3.69	0.95	0.06	0.06
Storm sewers	10.50	2.73	10.74	0.53	0.18	0.18
House connections	0.00	27.60	0.00	0.00	1.84	0 00
	$180.57	$45.81	$71.59	$9.03	$3.05	$1.21

Results in Table 10 show that if the space between houses on main streets is increased one foot, the cost of streets and

utilities per house is increased $9.03. Also, if the front yard is increased one foot in depth, the cost of street improvements and utilities per house is increased $3.05, and if the rear yard is increased one foot in depth, the cost of street improvements and utilities per house is increased $1.21. These computations also bring out the fact that insofar as street improvements and utilities are concerned, 2.96 feet can be added to the depth of front yard, or 7.46 feet to the depth of rear yard, for the cost of adding one foot to the width of side yard; and that 2.52 feet can be added to the depth of rear yard for the cost of adding one foot to the depth of front yard.

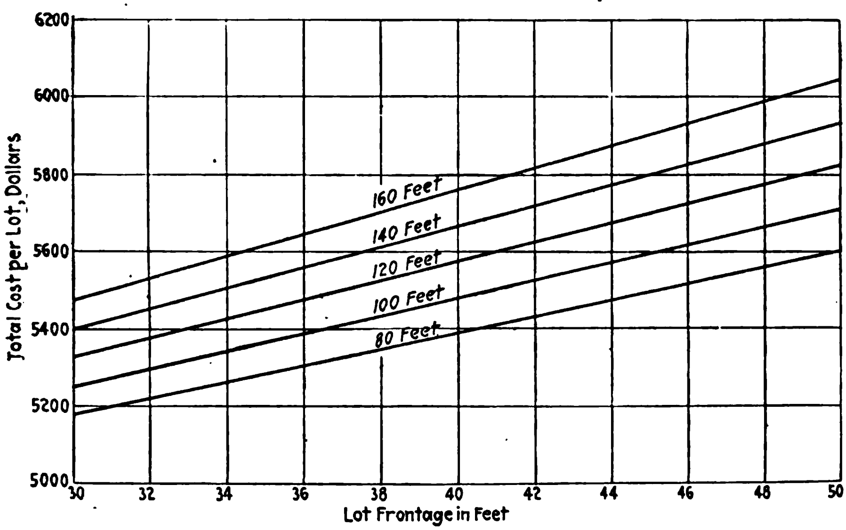

FIG. 15.—Diagram showing relation between lot frontage and cost per house, including land, for lot depths of from 80 to 160 feet; based on assumed average costs.

In a lot 42 feet front by 100 feet depth, the combined cost of land and lot improvements is equal to $369.71 or $8.80 per front foot. (See Table 1, Chapter II). If to this cost of land and lot improvements be added the cost of utilitites and street improvements on the main street per foot of side yard, the total cost per lineal foot of side yard is $17.83 (obtained by adding $8.80 to $9.03). Assuming rents are based on 12 per cent. of gross return, the cost in rent for each front foot of side yard is 18 cents per month. The relation between lot frontage and the cost per house is graphically shown in Fig. 15.

Although no general conclusions are justified, because only one assumed industrial town site has been discussed, it is interesting to note that cost per lot for "Street Improvements and Utilities" in this case is $875.43, compared with $369.71 for "Land and Lot Improvements";—the latter being 42 per cent. of the former.

If, however, the cost of street improvements and utilities is compared with cost of lot improvements and land, each directly chargeable to the 20 feet of side yard, they are respectively $180.57 and $176.05 (Computed from Table 10). In other words, granted that complete utilities and street improvements are to be installed, and with the conditions assumed for the purposes of this discussion, the additional cost due to the separation of the houses to provide side yards, is due in an equal extent to the additional cost of lot improvements and land, and to the additional cost of utilities and street improvements. It is thus clear that the cost of utilities and street improvements alone does not control the effect on cost of the spacing of houses, but does maintain a direct relation to the lot sizes.

The foregoing example is a problem in the total or community economy in the size and shape of lots, and for this reason the estimates include all items affecting the gross cost of the lot. An important distinction should be drawn between such gross costs, and the selling price or ordinary cost of the house and lot to the purchaser.

In computing the latter, the cost of all self-supporting utility lines, including gas systems, electrical transmission and distribution systems, water supply works and water distribution systems, and telephone trunks and lines should be deducted from the foregoing estimates, for the reason that the utility rates paid by the house owner (or tenant) cover the expense of these services in any well regulated community. A part of the cost of the water works system may be paid out of municipal tax levy,[1] in which case such charge would be added to the rental, but not to the selling price.

In many cases, particularly where the development is not directly adjacent to existing utility systems, the land company may be required to advance all or a certain percentage of the cost of installing transmission and distribution lines, such cost later to be returned out of revenues; or perchance at an arbitrary

[1] See page 188, Chapter VI.

refund rate per year. In such contingency only the actual cost of the transaction to the land company should be chargeable against the selling price of the lot.

If the development is organized as a municipality, or is located in an existing municipality, it is customary to pay the cost of such trunk sewers, sewer outfalls, and treatment works as may be required out of tax levy, together with a certain percentage of the cost of the laterals, usually from 10 to 35 per cent. The same plan generally applies to street surfacing and improvements, where the municipality may pay from 10 to 66⅔ per cent. of the total cost of such work. In these cases only the actual cost assessed against the adjoining properties is to be directly charged into the selling price of the lot, although all such charges should be represented in the rental figure, which includes taxes.

All other expenses of development, however, including cost of land in the lot, proportionate cost of public land in the streets, etc., original cost of laying out and grading streets, lot improvements, house connections, the cost of the house itself, all administrative, superintendence and overhead charges in connection with the same, together with interest during construction and carrying charges thereafter, are directly chargeable into the cost of the lot and house.

SUMMARY OF PROCEDURE

It will be found that the town plan can be most effectively prepared if a program substantially in accord with the following is adopted.

a. Secure an accurate topographical map, based on a careful survey.

b. Make a careful inspection of the site, and an examination of all physical and local conditions that will influence the plan.

c. Collect and consider all available information and data bearing upon the development of the plan, the growth of the community, and districting.

d. Make preliminary study and prepare general plans of utility systems.

e. Make a preliminary study or general plan of the street system including main thoroughfares and arterial streets, which may be conveniently prepared upon a reproduction of the topographical map.

f. Prepare a general plan showing block and lot subdivisions.

g. Make study for districting or zoning of the area with regard to character of use, area occupied, height of buildings, and prepare building and sanitary regulations.

h. Make a house location plan, showing the placement or spotting of the houses on the lots.

i. Prepare a landscape and planting plan, showing the parks, boulevards and parkways, playgrounds and planting of these areas, streets and individual lots.

j. Prepare working and detail drawings of all parts, including streets and utility systems, modifying as relationships develop.

If the projected development is of relatively small size, it may be advisable to reduce the number of plans above suggested, either by omission or by combination.

Topographical Survey and Map.—The first step in the procedure is to make a topographical survey and prepare a map of the area to be improved. If the plan is to be satisfactory in all its details, the underlying information must be reasonably complete and accurate, and for this reason, as the topographical map will be the basis for the whole design, it should receive the early and constant attention it deserves.

A reasonable degree of accuracy should be fixed and thereafter maintained. Triangulation and the running of control lines will depend as to extent and accuracy upon the character of the topography and the size of the tract. Important points and lines should be well referenced, so that they may thereafter be easily located and identified.

The contour intervals to be adopted will depend upon the character of the topography. Where steep slopes predominate, and where there is considerable variation in elevation, a five-foot contour interval, which is the maximum, should be used; where the area is generally level, a one-foot contour interval will be required. Frequently a two-foot contour interval will suffice.

The maps should be drawn on a scale of from 1 inch = 40 feet, to 1 inch = 200 feet; the scale being dependent upon the size of the tract and character of the topography. Preferably the scale should not exceed 100 feet to the inch. Duplication of work in replotting on various scales should be avoided, if possible, by adopting a scale that can be used with convenience for different purposes. It frequently will be necessary to extend the topography somewhat beyond the boundaries of the development, in order that the improvements within the site may be planned with due regard to the possibility of extension into adjoining areas.

The topographical map should show the following:

(*a*) Boundaries of property lines of the tract and existing subdivisions, if any, with distances and bearings or deflections indicated.

(*b*) Wooded areas, indicating outlines of large groups or groves of trees; individual trees, five inches or larger; indication of species and condition.

(*c*) Natural features, as water courses, with high and low water lines; swamps and rock out-crops; sand and gravel banks; stone quarries; nature of top soil, etc.

(*d*) Soil and foundation conditions; test pits and borings; ground water elevations.

(*e*) Fence and wall lines; existing roads and drives; bridges; culverts; street improvements and utilities; buildings; steam and electric railroad lines and sidings, with elevations at base of rail.

(*f*) Contour lines.

The foregoing should be indicated by easily distinguished legends or conventions.

Regional Maps.—It will generally be advisable, particularly when new street and utility systems are to be planned, to prepare a map of the region, wherein the development is located. This is for the purpose of studying the relation of the project to the surrounding district, the extension of existing utilities, and the influence and relation of existing and projected highways and streets to those of the proposed town. It is not the purpose of such regional maps to portray conditions in minute detail, but rather in such a way as to enable a study to be made of problems and interrelationships between the new town and the surrounding territory and neighboring communities.

It will further be convenient to show on the regional map important features of existing water supply and sewerage systems, main traffic lines, freight stations and yards, and other information of like kind.

The labor and cost of preparing the regional map may be reduced by utilizing and collating existing available maps and plans of the municipal and public service companies. Frequently the topographical sheets of the United States Geological Survey may be used to advantage, as a base or general map for assembling data thereon.

Site Investigation.—Serious delays and confusion will be avoided and better coördination in design obtained if a thorough, and preferably a joint investigation, of the site is made by those in responsible charge of the town planning, architectural and

engineering features of the work. There is no better way to sense and evaluate the main features, conditions and problems than by such investigations. Many mistakes and misconceptions will thereby be avoided.

The main purpose will be to obtain first hand information and impressions to serve as a guide in later formulating the planning and construction policies, and to aid in the interpretation of maps and data. The soil conditions, for instance, will be of interest to the engineer and the architect alike. There will further be many points relative to opportunities for location of sidings and yards, the planning of construction roads and similar features, that will be of value in planning the town and the construction program.

Preliminary Town Plan.—The preliminary town plan will be developed to determine the main features, especially those which are dictated by the existing conditions and topography, existing highways, transportation and utility systems. In forming the plan, not only the principal requirements of the street system, but those of the best utilization of the land as to commercial and residence districts, larger parks, the utilities and of the various types of buildings are to be considered.

It will be convenient to project this study on a positive Van Dyke or gelatine reproduction of the base topographical map, so that copies can be used for revision and for the development of the utilities systems. Trial profiles and cross-sections of the streets should be worked up at the same time.

Final Plan of Development.—The preliminary town plan will be subjected to such modifications and revisions as may be necessary to produce a well balanced, consistent, efficient and economic plan. This will require adjustment, the degree depending upon the relative importance of the design of the street system, those of the various utilities, and, particularly, the requirements of the houses, as has been hitherto discussed under property subdivision.

The complete town plan should show the street system in detail, including the name, widths and grades of the highways; the various features of the plan, including the civic center, schools, etc.; the subdivision of the property into blocks and lots; set-back lines, open spaces, parks, etc. The plan should contain essential information as to distances and geometry which will enable it to be staked on the ground. Frequently such plan can be later

filed in the office of record in connection with the dedication of streets and the recording of the sub-division and the decision as to scale should be based on such a use.

The adopted town plan will include profiles of the various streets showing the established grades thereof. The latter is important on account of the legal significance and practical value.

Detail and Working Plans.—Detail and working plans will be required for the various parts of the work. The number, variety and scale of these plans will depend upon the scope of the work and upon conditions and variety of detail.

Grading plans for the general improvement of the site and final grading of the lots will be essential to determine the best elevation of the houses and the quantity and disposition of material. The topographic map may be used for working out the general scheme and to determine approximate quantities, but to be efficacious for field use should be on a scale of not less than one inch to 100 feet; preferably one inch to 50 feet. Detail cross-sections of cellars, lots, sidewalks and streets may be required for this purpose.

It will often be economical to prepare working drawings to a scale of forty feet to the inch or less, to show the lines and elevations for lot grading, planting, house walks and house location. The same sheets, or reproductions thereof, can later be used as a base plan for record drawings of utilities.

RECENT COMMUNITY DEVELOPMENTS

Ojibway, Ontario.—The plan of the projected town of Ojibway, Canada, contains a number of interesting features which will serve to illustrate some of the points heretofore discussed. This plan was prepared by the late Owen Brainard, with Carrere and Hastings as Town Planners, in association with the author as Engineer, to provide housing for employees of the new plant of the Canadian Steel Company, Limited, at Ojibway near Windsor, Ontario, Canada.

As will be seen in Fig. 3, the street system is on the rectangular plan, with a radiating system of diagonal streets, serving as main and secondary arteries. The tract reserved for the town consists of about 650 acres of nearly level ground, the maximum difference in elevation of the surface being about 8 feet. When fully developed, the town will provide for about

21,000 people, housed in detached houses, on lots generally of 35 feet frontage and 120 feet in depth. The towns of Windsor and Walkerville lie to the north, and the steel plant to the west, between the town and the Detroit River. An electric railway line is located on Main Street and provides rapid transit to Windsor, Walkerville and other local points. The tracks of the Essex Terminal Railroad are parallel to and located directly in the rear of the blocks fronting on the west side of Main Street. Important existing through highways include a road lying some distance east of and roughly paralleling the town site, and Machette Road, also an important highway, which passes through the development approximately on the line of H Street.

The principal features in the plan are as follows:—

Main Street, with a width of 100 feet, will provide for business and small local industries which will be attracted there by reason of the street railway, the siding facilities of the properties on the west side of the street, and the proximity to the plant. The higher class commercial establishments and amusements, together with the community or civic center, will be located in the area immediately east of Main Street and bounded by 16th Street, G Street and 12th Street.

Ample provision is made in the planning of the main thoroughfares for the requirements of through traffic and inter-communication, not only as concerns the development, but also the undeveloped territory adjoining to the east and south. Through traffic from the southeast, coming over the existing Machette Road, by following the line of South Avenue and G Street, will be diverted from the business center.

The main thoroughfares are from 100 to 160 feet in width, and are generally provided with central parkways. The secondary streets are 86 feet in width, with central parking area. A further prominent feature of the street system is a parkway 300 feet in width, with a wide central parked area extending from the commercial district to G Street, the main north and south street. The residential districts are laid out with 50-foot streets. Alleys are not provided except in the commercial district.

The street system was adopted only after thorough investigation had been made of the requirements of traffic and utility location, particularly that of sewerage and drainage; the radiating system of main highways lends itself readily to these requirments.

Loveland Farms.—The street plan of Loveland Farms is an excellent example of the adaptability and economy of the use of contour streets in the development of a site characterized by rugged and broken topography. This development was designed by John Nolen, as Planner, with the author as Engineer. The project was built by the Youngstown Sheet & Tube Company, for the purpose of providing modern type homes for skilled employees, foremen and superintendents. The site is just beyond the city limits of Youngstown, Ohio, and south of the Mahoning River. The gross area of the tract is 220 acres; area of streets 24 acres; gross area of parks and open spaces, 5 per cent.; net building or saleable area, 71 per cent., or 156 acres; approximate number of lots, 1,000; average lot area, 0.158 acres, or about 6,500 square feet.

It will be noted that the street plan, which is shown in Fig. 2, is composed very largely of curvilinear streets; in fact about 67 per cent. of the streets are so designed. The plan of the streets was dictated by the topography, which is severe, and by the adjoining existing roads. Poland Avenue, Loveland Road, Midlothian Boulevard and Oakland Avenue were existing improved streets and form the boundaries of the site. Poland Avenue, a main thoroughfare occupied by a 2-track street railway, furnishing transportation facilities from Youngstown to the site and points beyond, is the northerly boundary.

The ground rises from Poland Avenue, which has an elevation of from 860 to 870 feet to a maximum elevation of 1030 at the southwest corner of the plot. The ground surface is further broken by ravines extending back from Poland Avenue. The main streets, following the contours, are laid out on approximately concentric circular arcs, with an approximate center at the summit of Ridgewood Road near the southwestern corner of the plot. Streets leading to Poland Avenue generally follow the line of ravines, which afford the most favorable location, and make possible an effective subdivision of the adjoining property, which otherwise would be difficult.

The chief features of this plan are the economy of site development and improvement, the effective subdivision of the property and good street grades obtained on a very hilly site. The use of court streets, to develop deep blocks upon steep hillsides, will be noted.

As the facilities offered by existing highways and topographical

barriers made a minor consideration of the necessity for providing for through traffic, the streets within the development are mainly laid out to provide good building frontage, access, and intercommunication, with reasonable facilities for traffic passing through the plot in an easterly direction from Powers Way and other connections. The character of the development will be entirely residential, except for a small business district to be located in the vicinity of Ridgewood Road and Ohio Square. The street widths are 40, 50 and 60 feet, with roadways of 18, 24 and 32 feet, respectively. Sidewalks are 4 feet wide on the 40-foot streets and 5 feet in width on the other streets.

Yorkship Village.—Yorkship Village was the largest governmental housing project constructed during the War. It is of great interest not only on account of its size, but for the reason that the plan contains many unique features and represents great advance in the planning and development of large towns for industrial workers. The town was planned under the general supervision of the Emergency Fleet Corporation, for the Fairview Realty Company, a subsidiary of the New York Shipbuilding Company, for the shipyard employees of that company in Camden, N. J. Electus Litchfield was Architect and Town Planner, and Lockwood, Green & Company, the Engineers. (For street and block plan see Fig. 16.)

The tract lies at the southerly extremity of Camden, N. J., and has recently been annexed to that municipality. The site is a practically level tract of land bordered on the north, south and west by small tidal streams, or estuaries, whose marginal mud flats and high water lines limited and defined the useful area in these directions. The Mt. Ephriam Pike, an improved highway, is the easterly boundary of the plan, and affords a highway connection to Camden. Collings Road traverses the site from east to west and provides an existing highway leading directly to Broadway, a main thoroughfare in Gloucester which extends along the river from Camden. An extension of a street railway on a private right of way, from the main line on Broadway in Gloucester to the project, which it enters on Collings Road, affords street car service to the shipyard, Camden and local points.

By reason of the foregoing condition, and with the exception of the existing highways before noted, whose influence on the organization of the plan will be apparent, the site was isolated

from Camden and was therefore to be developed as an independent community. The necessity of providing a more direct

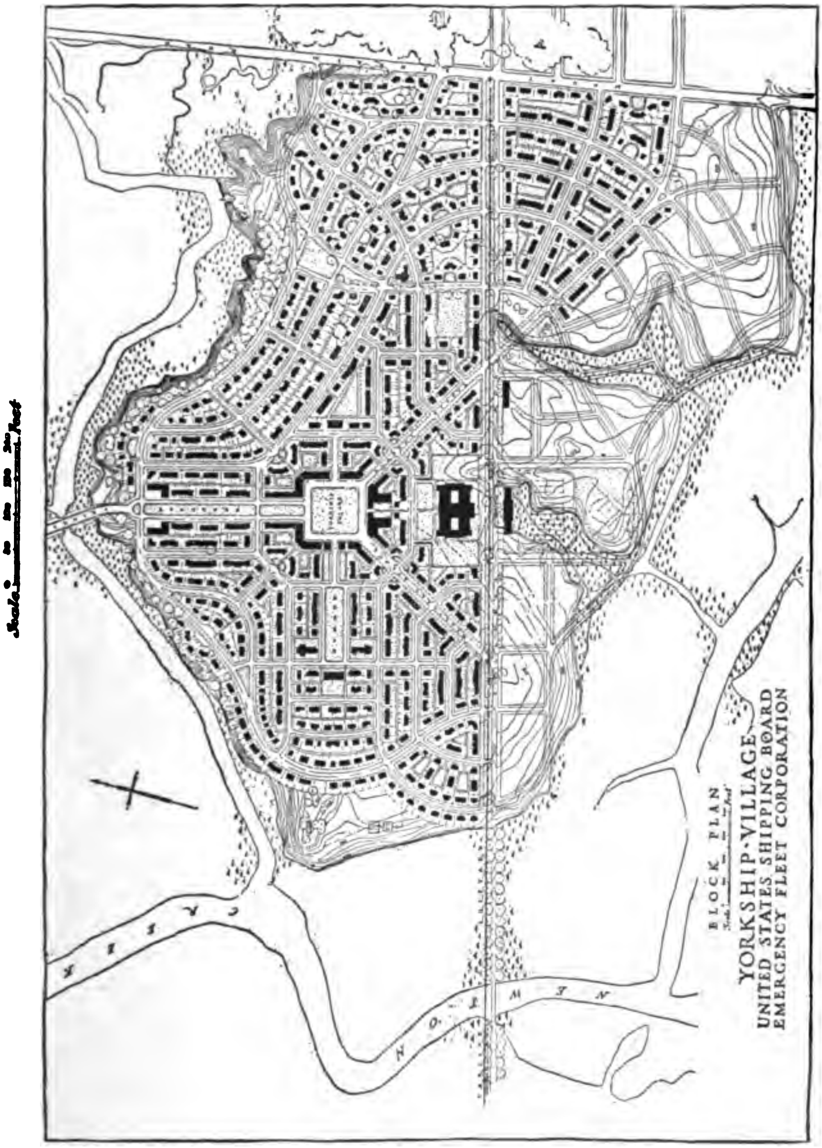

Fig. 16.—Plan of Yorkship Village (Camden, N. J.), built during the war by the Emergency Fleet Corporation.

route for pedestrian and vehicular traffic from the town to the shipyard, which lies within walking distance to the northwest,

imposed a further condition which greatly influenced the development of the town plan. This connection was accomplished by building a concrete arch bridge, crossing the branch of Newton Creek to the north of the town, and opening up a new street leading to Morgan Street in Camden. This latter street leads to Broadway and the shipyard plant.

The main approach street, which is also the main axis of the layout, is a parkway 120 feet in width, extending from the bridge to a central square, which was planned to be the social and community center of the town. About this square are located the more pretentious buildings, including apartment houses, stores and a projected community building. A park area 140

FIG. 17.—Yorkship Village; the central square and parkway.

feet in width extends westward from the square and constitutes the minor axis of the plan, and affords an excellent location for churches. Radial streets extend from the southwestern and southeastern corners of the square to Collings Road.

The central features of the plan have a decided element of formal organization which does not predominate in the outlying section. While curved streets are used to a limited extent, frequent angles, combined with effective placement of dwellings and features, make for attractiveness and interest. The easterly section, the streets of which are laid out as concentric circular arcs, was designed after the plans of the main portion of the town had been adopted.

The total developed area is 179.1 acres; area of lots is 80.4

acres, or 44.9 per cent.; sites for special buildings, 1.8 acres, or 1 per cent.; schools, recreational and community purposes, including parks and playgrounds, 35.6 acres, or 19.8 per cent.; area of streets and alleys, 61.3 acres, or 34.3 per cent.

The town includes 1,386 dwellings, of which 1,018 are in rows and the balance detached and semi-detached houses. There are also four apartment buildings, one hotel, and eight stores. There are 16.45 dwellings per acre of lot area, the average lot containing 2,526 square feet. The gross building density is 7.8 dwellings per acre of the developed land, including lots, streets and other areas.

CHAPTER V

STREETS AND PAVEMENTS

Classification of Streets—Pavement Design—Type and Materials of Pavements—Accessory Structures

The paving and appearance of the streets of a community is one of the first things which attracts the attention of the visitor and also greatly affects the comfort and convenience of the residents. It is an item on which either too great or too small a sum may readily be spent, and a very careful engineering study and planning are necessary to determine the proper design so that the utmost utility and economy is subserved.

CLASSIFICATION OF STREETS

The general plan of the street system, together with the classification of streets and their location has already been considered in the preceding chapter.

Widths for Different Services.—The importance of streets is determined by the character of the expected traffic. Width, even more than the character of the pavement, indicates this importance. Widths of streets are determined by the volume and character of the traffic which will use them. American municipal practice in fixing street and roadway widths has been, to a very large extent, controlled by local practice and by too strict adherence to artificial standards. Street widths cannot be standardized, although the maximum and minimum may be defined, which should not be departed from except under unusual circumstances. See Fig. 9 for typical street widths and cross-sections.

In some communities there has been a tendency to make widths of streets and roadways entirely too narrow; in others, particularly in the middle west, roadways of unusual widths are often required by municipal ordinance. The latter are objectionable, as they increase the cost of improvements, street cleaning and replacement. Arterial or main traffic streets often become congested and sub-arterial and residential streets frequently are of greater width than economy requires. Traffic may be forced to

seek streets which are designed to care for the lightest travel only, thus causing a rapid deterioration of the surface. The results of such a policy will prove expensive to the community and waste valuable space. The logical method is to base the required width of roadway upon the number of traffic lines which the roadway pavement must accommodate, due consideration being given to the gradual increase in recent years of both the width and speed of vehicles.

Arterial or Main Traffic.—Such main thoroughfares will be required to carry the street cars and bus lines, in addition to the usual vehicles; and provision for these should be made at the time of the design, wherever they will be required in the future. Street car tracks should preferably be placed in the center of the roadway, and it is desirable that they be on a separate right of way, which may be divided from the rest of the street by a curb. This will allow the cars to move at a greater speed and with less danger to other traffic. The increased speed thus made possible will extend the available zone of residences for the community, by lessening the time required for transit from home to the business district.

On arterial and main business streets provision should be made for two, four or more lines of traffic and either a single or double track car line. In addition to this a sidewalk should of course, be provided on each side of the street. The increased speed, at which traffic moves in well regulated communities, requires a comfortable clearance. This indicates a minimum width for each line of vehicular traffic of at least eight feet, and preferably nine feet. The lower figure can be used where several lines are provided for, and the latter on the narrower streets.

The width of sidewalks on a business street should never be less than 12 ft. and in larger communities, and on important streets, may exceed this amount. This entire width need not be paved in the early period of the life of the community, but this space should be reserved for public use.

A typical determination of the width of an arterial street is as follows:

Two lines of parked vehicles	16 feet
Four lines of traffic	36 feet
Two car tracks	20 feet
Two sidewalks	28 feet
Total	100 feet

This example indicates the width for a street of this class in a community where growth may be expected; lesser widths may be used in certain cases by using fewer multiples. The whole breadth need not be paved until the volume of traffic demands it. A planting space may be reserved on each side of the paved section of the street, which later may be assigned to the use of traffic when required; or the additional width may be temporarily allotted to the abutters for front yards, with reservations requiring that the building lines be kept back the desired distance.

Subarterial or Secondary.—Subarterial streets may vary considerably in width, because of the different sizes and character of the districts which they serve.

The roadway should contain space for at least two lines of traffic and parking space at either side, and it may often be necessary to provide for four lines of traffic. Very frequently a single track car line will be required to lead from the main thoroughfare to the subsidiary district. The sidewalks should be allowed a space of at least 12 ft., part of which may be utilized as a planting space. A typical design of the width of a subarterial street is given below:

One car track	10 feet
Two lines of traffic	20 feet
Two parking lines	16 feet
Two sidewalks and margins	24 feet
Total	70 feet

In the smaller industrial communities, which are adjacent to larger towns, the streets here classified as subarterial may be then called the principal streets. In such cases the car track is frequently not required, and occasionally the total width between property lines may not exceed 50 ft. This is the absolute minimum which is to be recommended for streets serving more than the lightest residential traffic. This width may be divided as follows:

Two sidewalks and margins	24 feet
One parking line	8 feet
Two lines of traffic	18 feet
Total	50 feet

This gives a roadway 26 ft. in width, with a 12-ft. space on each side for sidewalk and planting.

Ordinarily subarterial streets should not be designed less than 60 ft. in width and usually they will not exceed 80 ft.

Residential Streets.—The function of the residential street is to furnish access, light and air to the abutters. Traffic should be confined to pleasure vehicles and the delivery of domestic supplies.

In the industrial community residential streets may vary somewhat in character. A large part of the buildings facing on one street may be apartment dwellings, on another the larger homes of superintendents, foremen and the like, and on another the less expensive homes of the unskilled laborer. The residents on the first two streets will desire and will be able to pay for wider streets, and consequently it may be desirable to give them extra width to allow for planting and for the larger amount of traffic which such districts will require. Such streets may be from 50 to 80 ft. in width but ordinarily will not exceed 60 ft. The design given below is well adapted to the more important residential streets in many industrial developments.

Two sidewalks and planting strips	26 feet
Two lines of parked vehicles	16 feet
Two lines of traffic	18 feet
Total	60 feet

This design provides a roadway of 34 ft., with a sidewalk and planting space on each side of 13 ft.

A more pretentious design is as follows:

Two sidewalks and planting strips	26 feet
Two lines of parked vehicles	16 feet
Two lines of traffic	18 feet
Central planting strip	20 feet
Total	80 feet

By far the greater number of people live on what may be called minor residential streets, which are side streets leading from arterial, sub-arterial and principal residence streets. These streets should seldom be less than 40 ft. in width, except in special cases, such as hillside streets with dwellings facing on one side only. This width of 40 ft. is required in order to give a desirable amount of light and air and to present a desirable appearance.

The paved portion of such a street should never be less than 18 ft. in width and many engineers are recommending 20 ft. as a desirable minimum. This width allows two vehicles to pass at a fair rate of speeds without danger of crowding the curb. In a typical 40-ft. minor residential street, 20 ft. is allotted to paved surface and 20 ft. to planting strips and sidewalks.

PAVEMENT DESIGN

The principal details of design center about the important items of grade, foundation, subsurface and surface drainage.

Grades.—The subject of grades has been touched on in the preceding chapter but will be discussed here in more detail. This question must of course be considered in making the layout for a town, but it again becomes one of the important engineering considerations in the design of the pavement. This illustrates the necessity of developing all parts of the design of an industrial community under one organization and head, in order that such problems may be well coördinated and the utmost economy secured.

While much of the present day hauling is done by motor trucks, which can climb grades that are too steep for heavy horse-drawn vehicles, the latter are still used to some extent. Therefore, on arterial streets, subject to this kind of traffic, the heavy horse-drawn vehicle limits the maximum grade. For a heavy team, operating without brakes, 5 per cent. is the steepest grade which can safely be used, and this should not be exceeded on streets carrying heavy traffic in localities where it is not customary to use brakes.

The cost of hauling also enters into the determination of the maximum grade of arterial streets, as this increases very rapidly as the grade increases. Wherever it is at all possible, 5 per cent. should be set as the maximum for arterial streets, and this grade should be exceeded only for very short distances on sub-arterial streets; less than this is of course very desirable.

Important residential streets should not be laid out where it is not possible to keep the grade down to about the limit mentioned above. On minor residential streets the grades may at times be as great as 10 per cent. for a short distance, but, except under very unusual circumstances, should not exceed this. Seven or eight per cent. is considered a desirable maximum for such streets.

In some industrial communities, the selection of the type of pavement is restricted, due to some special condition such as availability of certain materials. The maximum allowable grade then will be determined as that which is suitable for the indicated type of pavement. The following table gives the maximum allowable grades for different kinds of pavement, as recommended by the Special Committee on Materials for Road Construction and on Standards for their Test and Use of the American Society of Civil Engineers in its final report:

TABLE 11.—MAXIMUM ALLOWABLE GRADES FOR PAVEMENTS

Kind of pavement	Maximum allowable grade, per cent.
Broken stone	12
Bituminous concrete	8
Bituminous macadam	8
Cement concrete	8
Bituminous surface on gravel	6
Sheet asphalt	5
Brick—bituminous filler	12
Brick—cement grout filler	6
Stone block—grout filler	9

Foundations.—The stability and permanence of a pavement depends to a great extent on the stability of the foundation. If the foundation is weak or unstable, ruts and depressions form, and the pavement deteriorates rapidly.

The essential precautions which must be taken in order to insure a good foundation are as follows:

1. Removal of vegetable, perishable and yielding material.
2. Thorough compacting of the subsoil with heavy roller.
3. Drainage of the subsoil.

The first two items are self-explanatory. The third, which is of prime importance, will be covered in the next section. Every load which comes upon the pavement must be carried ultimately by the subgrade. Hence it is of the greatest importance that this be sufficiently strong and stable to carry the greatest load which it will be called upon to bear.

Very few States have as yet fixed the allowable loads on highways, but many are now considering this problem. In a short

time we may expect to see reasonable limits established, which will prevent the occasional extremely heavy loads which have destroyed a large number of pavements and foundations.

It is often necessary to use an artificial foundation, due to fills, yielding or spongy material, or material of a perishable nature, or to support a wearing surface incapable of taking bending stresses. The materials frequently used for such foundations are lump slag, broken stone, gravel, rough stone, or cement concrete. The first three are ordinarily used as in a macadam road, being well consolidated under the roller; the wearing surface is then laid upon the foundations. Rough stone is not to be recommended, except in special cases. The present high cost of Telford construction, together with its disadvantages cause it to be less favorably considered in most sections of this country.

Cement concrete is the most widely used artificial foundation, and a most satisfactory one. It furnishes a smooth unyielding surface for the laying of the wearing course, is strong enough to properly distribute the imposed load on the subsoil, and under proper conditions is practically permanent. It is used to a great extent as a foundation for asphalt, bituminous concrete, and brick and block pavements which would rapidly break up if not supported by a rigid base. Concrete for a foundation need not be of as good quality as when used for a pavement without a wearing surface, and it need not be so well finished. Mixtures as lean as 1:3½:7 have been used, although 1:2½:5 is recommended, except under unusually favorable conditions. It is constructed as later described under "Cement Concrete Pavements."

Subdrainage.—As previously stated, no matter what the paving surface of a street may be, the load which the traffic imposes on it must ultimately be carried by the subgrade. This must be stable or the pavement will ultimately break up, and the money expended for it will be lost. The supporting power of the subgrade is to a great extent reduced when it becomes wet, and hence it is necessary to keep it as nearly dry as possible at all times. This is true in all climates, and especially so in those subject to severe frosts, as a wet subgrade which freezes expands sufficiently to break the strongest pavement. It cannot be too strongly emphasized that it is useless to build good pavements without making careful provision for carrying off the ground water as rapidly as it accumulates.

To take care of the water that reaches the subgrade, a system of drainage is needed. This should be carefully designed by a competent engineer, in order to be sure that it will serve the purpose for which it is intended. There are several types of drainage; such as simple ditches, or an elaborate system of side and cross drains, consisting of pipe laid in some material like broken stone, which readily conducts water.

Underdrains are especially important where the soil is of such a nature as to hold water, or to prevent its draining off naturally, such as clay. On a sand or gravel foundation the drain at times may be omitted, but only when this is sanctioned by competent engineering advice. Details of the method of subdrainage adopted in the Loveland Farms Development are given in Fig. 18; effective subdrainage is provided for by constructing a broken stone and tile drain under each curb, which discharges into the storm inlets and to which the sidewalk subbase is connected at frequent intervals.

On unsurfaced streets, not completely improved, like lanes or country roads, the surface and subgrade drainage is ordinarily taken care of by means of deep ditches on each side of the pavement. If the street is on a side hill, it is, of course, necessary to construct the ditch on the upper side only, thus cutting off the ground water which would otherwise seep under the pavement. These ditches should be kept to grade and should have enough slope to carry off the water quickly; otherwise it will pool and saturate the road bed, making conditions worse than as if no ditches had been constructed. On the other hand, precaution must also be taken not to carry water too great a distance in side ditches with steep grades, as there will be serious danger of undermining the roadbed. In a flat country, it is often difficult to secure sufficient fall to provide a good run-off without making the ditches very deep, unsightly and dangerous. It may then be preferable to construct pipe drains.

A common method is to construct blind side drains, connecting with a tile pipe laid with open joints, leading to the storm water inlet. These drains may be about 18 in. wide and 24 in. deep, and filled with broken stone, slag, gravel or some other porous material. The size of pipe which is used in these trenches is ordinarily 4 in. or 6 in., the former being the more common. The size may be calculated in the usual manner, from the amount of water to be carried and the grade available. If water origi-

nates under the street or road, the drains may start at the center and run to the side in the shape of a V, *i.e.*, in a herring-bone system. Drains must also be constructed along the sides to carry off the water.

Frequently large drains are constructed along the side of the pavement, which are the same as the side drains described above, except that the pipe is omitted, and that larger stone is used in the lower part of the drain. The system is cheaper than the tile drain system, but is more likely to clog up with silt and become ineffective.

Surface Drainage.—Surface drainage is taken care of by sloping the pavements, so that water will run along it longitudinally, and by crowning the pavement, so that water will be carried to the sides of the roadway. The minimum longitudinal grade, which is sanctioned by American practice, is 0.25 per cent.; less than this will not provide for removal of surface water and deterioration of pavement will result. For water-bound macadam construction, it is advisable to make this minimum 0.5 per cent.

The camber or crown which throws the water to the sides of the roadway varies with the type of pavement, and in water-bound macadam also varies with the grade of the street. The maximum and minimum crowns recommended by the Special Committee on Materials for Road Construction and on Standards for their Test and Use of the American Society of Civil Engineers are given in the following table:

Table 12.—Maximum and Minimum Crowns for Pavements

Kind of roadway	Recommended crown—inches to foot width	
	Maximum	Minimum
Gravel	1	½
Broken stone	¾	½
Stone block	½	¼
Bituminous surface	½	¼
Bituminous macadam	½	¼
Bituminous concrete	½	¼
Cement concrete	⅜	¼
Brick	⅜	⅛
Sheet asphalt	¼	⅛
Wood block	¼	⅛

Catch Basins and Inlets.—Catch basins and drop inlets are necessary to intercept the water carried by the gutters and deliver it to the storm water drains. The design and construction of these are covered under Chapter VII.

TYPE AND MATERIALS OF PAVEMENT

The object of a pavement is to secure a watertight covering for the foundation, and to provide a smooth surface on which traffic may move easily, safely and at a low cost.

Selection.—The qualities of a good pavement may be stated as follows:

Low first cost and low maintenance.

Durability.

Sanitary and easily cleaned.

Smooth but not slippery, offering low resistance to traffic.

In addition to these qualities, it should be acceptable to those residing or doing business on the street. The term "acceptable" includes also "noiselessness" of the pavement. This is often a very important consideration, especially along residential streets and to a less degree on certain retail business streets. For example, a stone block pavement, although it possesses many desirable qualities, would not be desirable for a residential street.

No pavement perfectly meets all the requirements stated above, and it is necessary to carefully select the pavement which

TABLE 13.—RELATIVE WEIGHTS OF VARIOUS ITEMS IN THE IDEAL PAVEMENT

Qualities	Relative values for resid-dential streets	
	Main	Minor
First cost	15	23
Durability	21	21
Low cost of maintenance	13	13
Ease of cleaning	13	12
Sanitary quality	10	10
Non-slipperiness	7	5
Low tractive resistance	11	8
Acceptability	10	8
Total	100	100

most nearly approaches these requirements under the conditions which exist. In order to make this comparison, a table for the ideal pavement may be worked out, assigning a certain percentage to each of the qualities in proportion to the relative importance of each. The sum of these percentages will, for the ideal pavement, be 100, and the various types may be compared to this standard, and thus the most suitable one selected. The preceding table indicates these relative values for the residential streets of an industrial development. The values which are assigned below are not absolute, and should be modified to suit conditions.

As an example of the use of this method in determining the type of pavement to be used, a cement concrete and a bituminous concrete pavement for use on a residential street will be considered in the table below:

TABLE 14.—COMPARATIVE VALUES OF ITEMS FOR A CEMENT CONCRETE AND A BITUMINOUS CONCRETE PAVEMENT

Qualities	Cement concrete	Bituminous concrete
First cost	9	8
Durability	18	17
Ease of maintenance	11	9
Ease of cleaning	12	12
Sanitary qualities	9	9
Non-slipperiness	5	5
Low tractive resistance	10	9
Acceptability	7	9
Total	81	78

It will be noted that the above statement for these pavements compared with the ideal is good only for the conditions assumed in rating the various qualities of the ideal pavement. The value obtained for these assumed conditions is very high, for cement concrete and may not be exceeded by any other pavement. If the conditions were changed somewhat, so as to give "Acceptability" a higher value and "First Cost" a lower value in the rating of the ideal pavement, asphalt or bituminous concrete on a cement concrete base might be about as great as the concrete pavement. The selection of the type of pavement to be used under each set of conditions should be made only after a careful engineering study of the various items affecting it, but the

method outlined above indicates the manner in which the final selection should be made.

Local Materials.—Frequently the material readily found in the vicinity may be used for street surfacing, particularly for those not designed for heavy traffic or in the early beginning of a new development. Imposed conditions on industrial War towns made such imperative many times.

Earth Roads.—Where first cost is of the utmost importance it may be necessary to utilize the existing soil as the roadway surface. The disadvantages of this are obvious. The street will be muddy in wet weather and, unless oiled, dusty in dry; it ruts badly even under favorable conditions; it offers a high resistance to traction; is insanitary and presents a poor appearance; and the cost of maintenance necessary to keep the road passible is as great as for a more satisfactory pavement.

Its first cost is of course low, as it is only necessary to construct drains and prepare and shape the road as for a foundation, removing the softer material and the stones. On a gravelly soil fair results may be obtained by this method, but in clay it is usually quite unsatisfactory.

Sand-clay Roads.—When clay or sandy soils predominate, and it is necessary to keep costs to the lowest possible point, a sand-clay surface may at times be built. This type is open to the same objections as the earth to a lesser degree. The success or failure of these roads depends upon the mixture of sand and clay. Field and laboratory examinations should be made to determine the proper proportions.

Sand-clay roads should be located so that they will receive several hours of sunlight during the day, in order that they may dry quickly. They should be thoroughly drained, and the crown should be sufficient to carry all water quickly to the side of the road. The subgrade should be left flat, or nearly so.

The clay and sand are mixed by ploughing; the sand is spread on the ploughed clay or *vice versa*, and the surface is harrowed, shaped and sometimes rolled with a light roller. The mixture should be 5 or 6 inches thick at the sides and 7 or 8 inches at the center.

The sand-clay road is not durable nor very satisfactory for a town or village, and can only be considered as a temporary expedient. The hauling incidental to the construction of the utilities and houses is heavy enough to necessitate the entire

rebuilding of such a road surface, and hence it is not to be recommended except under unusual conditions.

Gravel Roads.—The gravel road is low in cost and may frequently be recommended for minor residential streets as best suiting all conditions where first cost is a predominating factor. Gravel is locally obtainable in many places; is cheap; and by proper proportioning may be made fairly satisfatory as a surfacing material. Beach, lake or river gravel is not suitable for this purpose, due to its smooth surfaces and lack of binding material. Unscreened bank gravel is often used, but this should only be done when approved by a competent highway engineer.

In constructing a gravel street surface the subgrade should be prepared, as for other types, by removing all soft or vegetable material, and by thorough rolling. Close attention should be paid to the drainage of the subsoil and to the removal of surface water. The gravel is then spread on the street, care being taken to spread it evenly. Stone larger than 1½ in. should not be used. A crown of ¾ in. per foot is ordinarily used, though this is sometimes decreased somewhat. The material is then wetted and rolled until thoroughly compacted.

This type of pavement is not suitable for any considerable amount of motor traffic. When this does not occur it can be maintained quite cheaply, but this requirement rules it out for all except the less important residential streets.

Miscellaneous Materials.—In various sections of the country other natural materials have been used to considerable extent and with more or less success. Among these may be mentioned chert, beach shells and shale. These as a rule have been employed more extensively on country roads than on town or city streets, and are in fact better adapted to such use.

Prepared Material.—*Water-bound Macadam.*—Water-bound macadam is similar to gravel surfacing, but constructed with crushed stone of suitable sizes in place of gravel. It is not a durable type where subjected to a considerable amount of motor traffic, as the fast moving wheels suck the fine binding material from between the stones and cause the pavement to ravel and disintegrate. It may be used for minor residential streets, where such traffic is light, but under any other conditions the cost of maintenance is excessive, and the annual cost per square yard is much higher than for more durable types of pavement.

In laying water-bound macadam the interstices are filled with

small particles and with stone dust, sprinkled and rolled until firm and hard. It is ordinarily constructed in two layers. The lower layer is of larger stone, and of a thickness of from 4 to 8 in. depending upon the subsoil and the amount and character of the traffic. The upper course is usually about 3 in. thick. The size of the crushed stone may range from 1¼ to 3 in., according to the quality and character of the stone, and the type and amount of traffic. In the selection of the broken stone or slag for the upper course, toughness, resistance to abrasion, shape, cementing quality, and cleanliness should be considered. Laboratory tests to determine these qualities should be made on a stone whose characteristics are not known.

A crown of ½ or ¾ in. per foot is used. On steep grades the greater crown is recommended, in order that water may be carried to the gutters quickly and not run down the street on the macadam surface, causing the binding material to wash out and the surface to disintegrate. Although sometimes used, it is not desirable that this type be employed on grades greater than 5 per cent., because of this tendency.

A surface treatment of light refined tar or asphaltic oil is of value in tending to prevent the pavement from ravelling. The oil should be applied by a pressure sprinkler, and then covered with sharp coarse sand.

Macadam with Tar or Asphaltic Surface.—This type of surface on water-bound macadam makes it better able to withstand the effects of rapid motor vehicles. It is rather slippery, and should not be used on grades above 4 per cent It also tends to creep, forming ridges across the roadway, unless very carefully constructed under competent control.

In order to apply a surface of this kind, the roadway must be swept clean, in order to remove all the surface dirt and the stone dust filler, to a depth of ¼ to ½ inch below the top of the large stone fragments. On this cleaned surface, a heavy refined tar or an asphaltic residuum is spread hot, and the roadway is then covered with a layer of stone screenings, and thoroughly rolled.

Bituminous Macadam.—This type has a wearing course of macadam with the interstices of the stone filled with a bituminous binder. It is usually constructed on a broken stone base, prepared in the same manner as the lower course of water-bound macadam. Pavements of this class have also been constructed having both courses bound with a bituminous filler. The qualities

of the stone for the wearing course should be considered as for water-bound macadam, except for cementing power. The stone should also have a rough surface, so that the bituminous material will adhere to it. The larger stone fragments should be 1 to 2½ inches in size, depending on the depth of the course. This is spread and rolled. Then a heavy grade of refined tar, bituminous residuum, or fluxed asphalt is poured hot into the voids, so that each stone is covered with a thin layer of bituminous material. Care should be taken that an excessive amount is not used, as this causes the surface to creep, forming waves which are extremely unpleasant to ride over.

A layer of ¼ inch stone or dustless screenings, is spread over the surface, and broomed and rolled until the voids are filled. A thick coat of bituminous material is then usually applied, and a thin layer of sand or fine screenings is then scattered on this. The depth of the top course is usually 2½ to 3 inches. The crown should be from ¼ in. to ½ in. per ft.

Bituminous macadam does not wash, is comparatively dustless, and is fairly easy to maintain. It makes a very comfortable riding road for fast vehicles, and if a flush coat is not used it is not slippery. It is not durable enough for heavy traffic, but stands up well under moderate loads.

Bituminous Concrete.—This type of pavement is composed of a mixture of broken stone, trap rock, gravel, gneiss, or slag aggregate and a bituminous cement, laid as a wearing course over a base of water bound or bituminous macadam or cement concrete. The mixture is prepared in specially designed equipment and mixed after heating the bitumen to the proper temperature, and preferably after heating the aggregate.

There are three distinct classes of bituminous concrete pavements in use today, which may be briefly described as follows:

First.—A bitiminous concrete pavement, having a mineral aggregate varying in size from about ¼ in. to 1¼ in., or as the material is received from the crushing plant after screening out larger sizes.

Second.—A bituminous concrete pavement having a mineral aggregate similar to the first class but with the addition of sand, stone screenings or similar material.

Third.—A bituminous concrete pavement having a definite mechanically graded aggregate of broken stone, slag, etc., with or without sand or other fine inert material. The sizes of mineral aggregate in this class vary by definite percentage from dust to about 1 in.

The first class represents perhaps the most common form of this type of pavement in use and requires somewhat less skill in preparation to get satisfactory results than do either of the other two. The second class is harder to control in securing uniform results and therefore is not so extensively used. The third class has found extensive and satisfactory use and includes several kinds of patented pavements. The scientific grading of mineral aggregate as called for in this class, produces a pavement of greater density and more uniform quality than the other two.

To secure the best results, the bituminous materials must be carefully selected in the light of past experience, and used under laboratory control, the material used generally being asphalt cements or refined tars. This phase of the subject is highly technical, and will not now be expanded. The materials for bituminous concrete paving may be mixed by hand, but it is better to use machine heating and mixing methods, as a more uniform product is obtained. It is impracticable to lay this surfacing in wet or cold weather.

After the material is placed on the road it is rolled, while still warm and pliable, to the desired thickness, usually 2 or 2½ inches. Rolling should begin at the edges and continue toward the center, and should be done with a 10-ton tandem roller. When the roller makes no ridges on the concrete, a seal coat of bituminous cement is usually applied to the surface, in quantities of ½ to 1 gallon per square yard, and the surface is then covered with stone chips and again rolled.

Bituminous concrete on a cement concrete base makes an excellent pavement. It is smooth, attractive in appearance, and when properly built is fairly easy to maintain. It is not so slipppery as sheet asphalt, which it resembles in many of its characteristics. It is comparatively high in first cost, which often prevents its use in industrial developments, and is not suitable for extremely heavy traffic, but under the usual traffic of residential streets stands up well.

It is often constructed on a base of macadam or bituminous concrete differently proportioned, but the results are not quite as satisfactory, and the annual maintenance cost per square yard is greater, as the foundation must be renewed from time to time.

Cement Concrete.—Cement concrete pavements have been rapidly coming into favor in the last few years, and at the present time large quantities of this type are being constructed.

From past records, it has been evident that cheap pavements are much too expensive to maintain on streets carrying any considerable amount of traffic, and the concrete pavement, probably more nearly than any other, represents the mean between macadam surfacing with high maintenance costs, and the expensive block pavements, and sheet surfacing over heavy foundations.

Concrete pavements may be made in either one or two courses, but the present tendency is to use the former. In two course work, the bottom course usually has an aggregate of a larger size and is sometimes of a leaner mixture. In this method of construction there is some danger of the upper course separating from the lower, with consequent disintegration. Concrete pavements of the one course type are usually built from 5 to 8 inches thick, common practice being to make them 6 in. thick at the outside and 8 in. thick at the center of the road.

Concrete is usually mixed in the proportion of one part Portland cement to two parts sand and three parts crushed stone or gravel. It should be emphasized that in the construction of cement concrete pavements the selection of only the best of aggregates is of prime importance. In order to wear uniformly the mixture must be as dense and strong as possible and this means that only good clean material, showing high abrasion test and graded in sizes, must be secured. Crushed trap-rock, granite or hard limestone are better than gravel for this purpose. The cement should be subjected to laboratory tests to insure best quality.

After grading and compacting the subgrade, it is placed on the road, where it is spread to the required depth and lightly tamped at the same time. After the concrete has started to set, it is finished either by hand, by the use of a roller and belt, or by a tamping and finishing machine. The use of a finishing machine is desirable, but excellent pavements may be constructed by the roller and belt method. Hand finishing by floats is not quite so satisfactory, as slight depressions in the pavements are unavoidable when this method of construction is used.

In city and town work the curb is often poured integral with the pavement itself. This is considerably cheaper than using a stone curb, as well as presenting a better appearance. The crown of a concrete pavement should preferably not exceed $\frac{1}{4}$ in. to the foot, and may be as little as $\frac{1}{16}$ in. to the ft.

Vertical joints to take care of temperature changes are ordi-

narily placed from 30 to 50 ft. apart, depending on climatic conditions. These joints should be about ½ in. wide and filled with a bituminous compound. There seems, however, to be

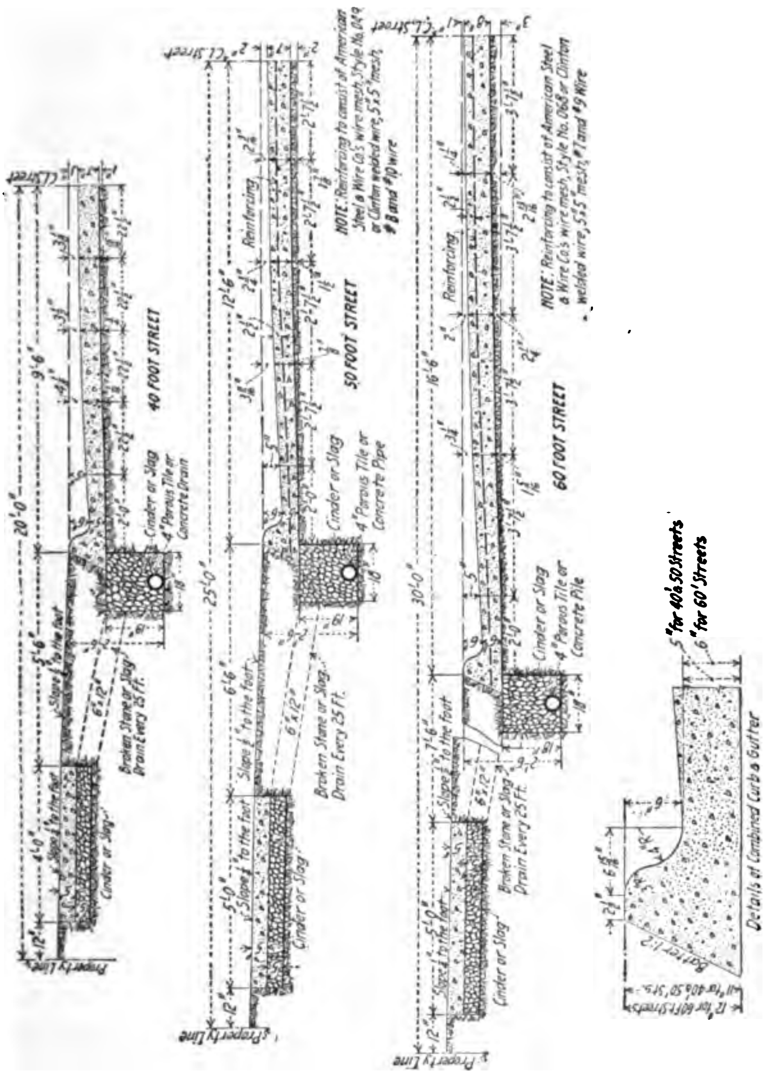

Fig. 18.—Street pavement and sidewalk construction; typical sections and details from the Loveland Farms Housing Development, Youngstown, Ohio.

some tendency away from using such joints, except where it is necessary to stop the work for a time, and at the end of a day's run.

Concrete pavements are constructed both with and without

steel reinforcement. In climates having considerable range of temperature, or where the subgrade conditions are not the best, it is commonly used. The weight and amount of the reinforcement is a matter for careful engineering study. This is usually in the form of woven wire or expanded metal and is placed near the center of the slab.

Details and typical cross-sections of plain and reinforced concrete pavement, constructed in the Loveland Farms Development, are shown in Fig. 18. A somewhat different design of cross-section and curb, is shown in Fig. 19, giving the details

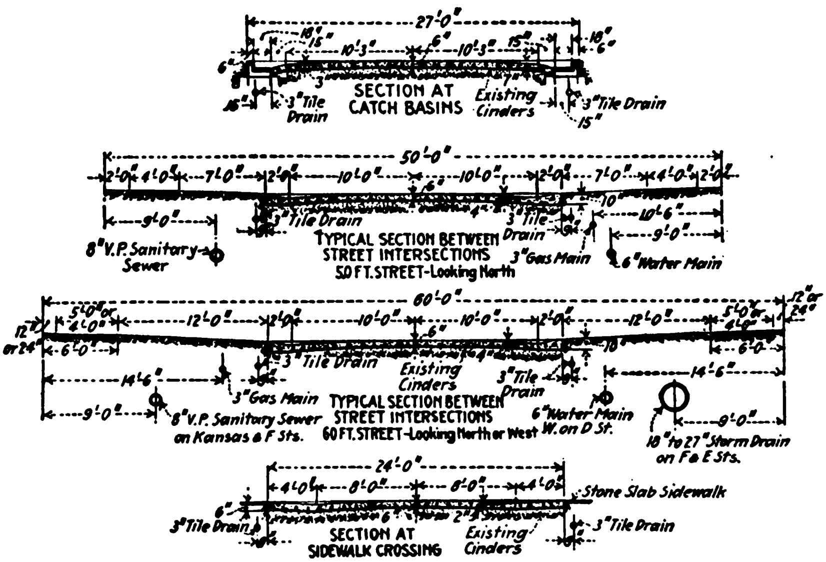

FIG. 19.—Details of street improvement and sub-structure location; Lorain Project of the Emergency Fleet Corporation.

of the pavements laid in the Lorain Project of the Emergency Fleet Corporation. In this latter case provision is made for later widening of the pavement and for future surfacing with sheet asphalt.

Concrete pavements are durable under heavy traffic and give a smooth, even surface which offers small resistance to traffic. The first cost is not high and the cost of maintenance is low if well designed and constructed. Concrete is easy to clean and is practically dustless. A disadvantage of concrete is that it cannot readily be cut to obtain access to subsurface structures.

Sheet Asphalt.—Sheet asphalt pavements have a wearing surface of asphalt cement combined with an inert aggregate of graded sand and filler, laid upon a foundation which is usually cement concrete, although bituminous concrete, old macadam, brick or stone block are sometimes used. The thickness of this wearing surface is usually from 1½ in. to 2½ in. depending upon amount of traffic to be carried.

The pavement is ordinarily built in two courses. The first course, called the binder course, is of asphalt and graded crushed stone, and varies in thickness from 1 in. to 1½ in. The aggregate is heated and then mixed in a rotary mixer, with a minimum

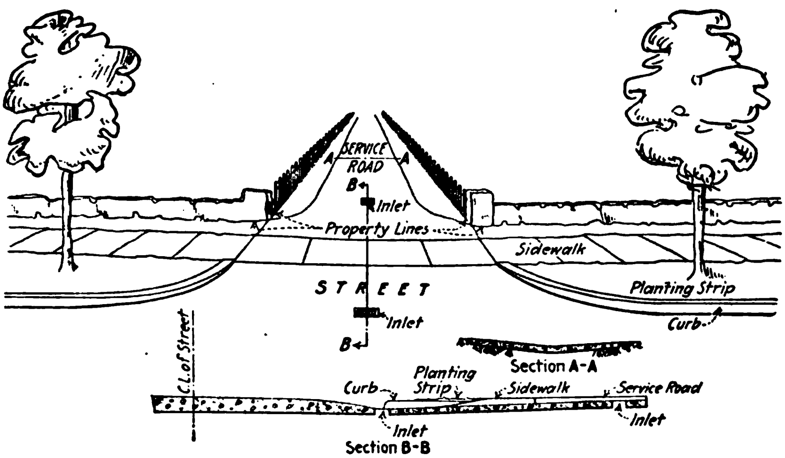

FIG. 20.—A suggested design for the intersection of a service road, or alley, with a street; the enlargement of the alley pavement at the intersection, and the flush sidewalk crossing are desirable features.

quantity, about 6 per cent., of refined asphalt. It is then spread on the foundation with shovels or rakes and rolled with a 5 to 7 ton roller. Sometimes the binder course is replaced by a paint coat, consisting of asphalt dissolved in naphtha, which is applied to the concrete foundation. The wearing course is placed directly on the binder or paint coat.

The aggregate of the wearing course consists of carefully graded particles of sand, ranging from the size of dust grains to about ⅛ in. in size. The sand constitutes nearly 80 per cent. of the surface mixture, and takes nearly all of the wear of the traffic. It should therefore be hard, clean, moderately sharp, and have a suitable surface for the asphalt to adhere to. It should be

free from organic matter, and should pack together well when dry.

With the sand there should be used a filler of very fine material, such as powdered limestone or Portland cement. This should be fine enough to pass a 200 mesh screen, in order to properly fill the voids in the sand. After mixing the sand and filler, the material should be heated to about 350°F. and then mixed with asphalt cement heated to about 300°F. It is then carefully spread on the binder course with hot rakes, taking care to loosen the material and to keep it uniform in character. It is then rolled, sprinkled with stone dust or Portland cement, and re-rolled.

Asphalt is smooth, dustless, almost noiseless, and is easily cleaned. It offers little resistance to traffic, is easily repaired, and is well adapted to residence streets and to business streets not carrying any considerable amount of heavy slow moving traffic. It is not suitable for streets which do not have a fairly uniform volume of travel, as it develops cracks if not ironed out by traffic. Concrete or brick gutters should always be used with sheet asphalt pavements, as asphalt subjected to continual moisture has a tendency to disintegrate.

It is not suitable for heavy grades on account of its smoothness. It is desirable to limit its use to grades of 5 per cent. or less, and on heavy traffic streets 4 per cent. is a desirable maximum. Sheet asphalt has not sufficient strength or stability to bridge over soft spots, hence the foundation must be rigid. Around car tracks it must be protected, or the constant jarring will cause it to break up. The cost of sheet asphalt pavements is about the same as bituminous concrete and not as high as block pavements.

Brick Pavements.—Modern brick pavements are usually built on a foundation of Portland cement concrete. They are occasionally laid directly on the subgrade, or on a foundation of broken stone or slag macadam, but ordinarily this is not to be recommended, as serious settlement is almost sure to take place and maintenance is excessively high.

There are three types of brick pavement laid on a concrete base, namely, the sand cushion, semi-monolithic and monolithic types. These differ only in the method of joining the brick surfacing to the concrete base.

The sand cushion brick pavement is constructed by spreading a layer of clean, coarse sand, about 1 in. thick, upon the concrete

base, and laying the brick directly on this sand cushion, on edge and at right angles to the line of the street. After each course is laid, the bricks are driven together before the next course is started. The joints in the brick may be filled, either with Portland cement grout or with a bituminous filler. On hillside work, the bituminous filler is preferred, as it offers a better foothold for horses. Where grades are low, the Portland cement grout is ordinarily to be preferred.

If a bituminous filler is used, the material, usually either refined asphalt or tar, is heated to the required temperature and poured into the joints by means of a special pouring can. This is best done on a warm day, and the brick must be perfectly dry, so as to allow the bitumen to adhere to them.

The cement grout filler should be very carefully mixed in the proportion of one part cement to one part clean sand, and should be kept continually in agitation until swept on the pavement. Sufficient water should be used to make the grout the consistency of pea soup. To avoid thickening of the grout, the surface ahead of the sweeper should be well sprinkled. The material is then poured on the pavement and thoroughly swept into the joints with stiff brooms. Care should be taken that it is not swept too far, as segregation of the sand and cement will then take place. After initial set of the grout has taken place, a layer of sand about ½ in. deep should be spread on the surface which should be sprinkled frequently for about ten days.

In the semi-monolithic type of construction, the sand cushion is replaced by a dry mixture of one part cement to three or four parts sand. This is apread over the surface of the concrete base to a depth of ½ in. and the brick laid, lightly sprinkled, rolled and grouted as before.

The monolithic type of brick pavement is built by placing the brick directly on the concrete foundation before the concrete has had time to set. It is then rolled and grouted as soon as possible. Where the brick are grouted in place expansion joints of bituminous material extending through the base are placed against each curb, in order to take care of expansion and contraction due to temperature changes. They are also sometimes provided across the pavement at intervals of 30 to 50 feet, but the tendency is toward eliminating these.

The monolithic and semi-monolithic types are tending to displace the sand cushion method of construction, which has not

stood up as well under traffic. The sand alone is not sufficiently stable to remain in the same position. The cement mixed with the sand in the semi-monolithic type overcomes this tendency, and a very satisfactory and durable pavement is obtained in this way. The monolithic type of construction is frequently used for country roads and even for streets in a town or city, and has given entire satisfaction. A monolithic brick pavement does not require as thick a foundation of concerte as the other two types, as the brick themselves add materially to the beam strength of the structure.

The paving brick now in general use are vitrified shale brick, vitrified fire-clay brick and slag, or scoria blocks. Of these the shale brick is most extensively used. They are made of the proper mixture of shale and clay, ground and mixed carefully. Water is added to bring the mixture to the desired consistency, when it is pressed through dies and cut to form the blocks. These blocks are heated in kilns, almost to the point of vitrification and then gradually cooled. The size of shale brick is usually $3\frac{1}{2} \times 4 \times 8\frac{1}{2}$ in. Slag or scoria blocks are made from iron furnace slag, and, while being used in England, only a limited use has been made of these in this country. Hillside brick having one edge beveled are used on steep grades.

The use of brick pavement has increased considerably in the last decade, and it is now extensively used on city streets and country roads. The first cost is relatively high, but the cost of maintenance is low. It offers a low resistance to traffic, is sanitary and easily cleaned. It presents a smooth surface, is dustless and gives an attractive appearance. Brick pavement is rather hard on horses, however, and is noisy, in this respect being second only to stone block. In industrial communities, its high initial cost will tend to prevent its use except on hillsides or on heavily traveled streets.

Stone and Wood Block.—Stone and wood block pavements are used in cities where the traffic is extremely heavy. But in industrial towns there will seldom be any need for them, except possibly near the manufacturing plant itself. Block pavements should be laid on a concrete base.

The wood blocks in most common use are of long leaf yellow pine, impregnated with from 16 to 20 pounds of coal tar paving oil or coal tar distillate oil per cubic foot of block. The blocks may be either 3 or 4 in. in depth and are laid with the grain

vertical. The blocks may be laid on a cement sand cushion, as in the semi-monolithic brick pavement with a sand cushion, or the concrete base may be painted with tar or asphalt and the blocks laid directly on it. The blocks may be grouted in place with a Portland cement grout or bonded with pitch or tar thoroughly mopped into the joints.

Wood block properly laid gives a smooth and durable surface. This type of surfacing is expensive, and if not kept perfectly clean is extremely slippery when wet. Trouble is sometimes experienced during the first year or two with the blocks "bleeding" in warm weather, covering the pavement with a sticky coat of tarry material.

Stone blocks may be laid either on a sand or dry mortar cushion, or directly on the green concrete, as described under Brick Pavements. The method of construction is similar to that heretofore described. Stone for good paving block should be of even texture, hard, durable and tough. It should break smoothly, so that good joints may be obtained, and should wear evenly, so that the road may retain a good surface. It should not wear slippery, nor break off at the corners. The best stone for the purpose are granite and sandstone. Limestone has been sometimes used, and certain grades are satisfactory, but frequently it is too soft and tends to cobble.

The grouted block stone pavement is the type recommended for most requirements, except on heavy grades; in this type the joints are filled and the surface covered with Portland cement grout, giving a smooth, and, if properly proportioned and applied, a good wearing surface.

Stone block pavements are expensive and comparatively noisy. They are not as smooth as most modern types of pavement, and do not present an attractive appearance. They are, however, durable and should be used on streets which are required to carry a large amount of very heavy hauling and may be used on steep grades.

Miscellaneous Types.—In addition to the types of pavement which have been described are others which are in more or less use in various localities. Among these may be mentioned rock asphalt, asphalt blocks, cobblestone, burnt clay and straw. The latter two are of very minor importance and are still in use only in scattered sections.

Rock asphalt pavements differ from sheet asphalt pavements

in that the mineral aggregate has been impregnated by nature with a bituminous cementing material, the mineral aggregate consisting of sand or limestone. This pavement has found only a limited use in this country and cannot compete in cost with sheet asphalt if laid on a concrete foundation. The natural material, in the form of soft rock is run through a crusher in order to pulverize it and is then shipped in open cars to the point of use. In the earlier pavements of this type constructed in America the principal objection found was that the percentage of bitumen was not uniform, and soft and hard crumbly spots would soon appear in the surface of the pavement, and its use was practically discontinued in most sections. Recently, in the south eastern states, this material has again been put on the market. It is claimed that the trouble formerly experienced in bitumen content is being corrected and the percentage made constant by analsyis and tests, and by re-mixing and proportioning the pulverized material. One of the most important advantages claimed for this material is that it does not have to be heated before laying, as do all other bituminous pavements, and therefore can be laid in isolated communities where an expensive heating plant is not available.

Asphalt blocks consist of blocks made by compressing under heavy stress a mixture of asphaltic cement and fine mineral aggregate. The mixture is practically the same as that used for bituminous concrete pavements. The blocks usually are about 5 in. by 12 in. in surface dimension and 2 to 3 in. in depth, and are laid on a macadam or cement concrete foundation and a fresh mortar bed ½ in. thick. The surface is then swept with fine sand to thoroughly fill the joints. This type of pavement has about the same appearance and service characteristics as a bituminous concrete pavement, and is easy to lay, but has not been found satisfactory on account of its poor wearing quality and difficulty of making repairs.

Cobblestone pavements are in use in many places, although few new pavements of this type are being built. They are constructed of selected natural hard sandstone of 4 to 8 in. diameter and laid on a prepared subgrade and cushion of sand. Care is necessary to wedge the stones together by use of smaller stones and a sand or gravel filler.

The actual construction of this type of pavement is similar to sheet asphalt except that the rolling of the surface must be

continued for a short period each day for several days. While in some cases the pavement is laid on a loose stone base, this practice is to be condemned and it is recommended that a cement concrete base be used wherever rock asphalt is considered for a wearing surface. The final appearance of a rock asphalt pavement is very similar to sheet asphalt and laid under similar conditions and uniformity of bitumen, should give service equally as good.

ACCESSORY STRUCTURES

Sidewalks.—The same qualities which are required in a good pavement are also necessary for a good sidewalk. It should be smooth, but not slippery, afford a good foothold at all times, be durable, non-absorptive, clean, wear uniformly and be low in first cost and in maintenance.

Widths and Slopes.—The width of the sidewalk should be determined in the same way as the width of a street and should not be considered merely as a function of the street width, as is quite commonly done. For example, in wholesale districts little sidewalk space is ordinarily required, although the streets need to be very wide. On residential streets, the walk is usually kept 1 or 2 ft. from the property line, and a width not greater than 5 ft. is ordinarily sufficient. On minor residential streets, 4 feet is often quite enough. Usually, the whole space between the curb and the property line in residential districts is not paved, part of it being reserved for a planting strips.

In order to shed water quickly, walks should be given a slope of ¼ to ½ in. per foot towards the roadway. It is very undesirable to slope the sidewalk toward the abutting property. Slopes above ½ in. are likely to be slippery and should not be used ordinarily; but slopes as great as ¾ in. per foot may be used for gravel and broken stone. A slope of ¼ in. to the foot is recommended for concrete and flagstone sidwalk paving.

Subgrade.—The subgrade should be prepared by removing perishable and spongy material, and by rolling and thoroughly compacting fills. Fills should be made in layers of about 6 inches, and should extend at least one foot beyond the edge of the pavement, in order to keep the foundation from being undermined by washing.

In the central and northern sections of this country, except when the subsoil is porous and conducts water readily, a porous

foundation of cinders, gravel, crushed stone, or slag should be laid under the paved sidewalk. This porous base should be connected to a drain, so that water which reaches it will be lead away. This may be done by building blind drains from the sidewalk to the underdrain to the curb. A thickness of 4 to 6 in. for the foundation is used, depending upon soil condition and temperature. For typical design see Fig. 18.

Concrete Walks.—Cement concrete is the most commonly used material for sidewalks, as it closely approaches the ideal. The first cost is moderately low, it can be made smooth but not slippery, and is durable, clean and attractive. The concrete pavement is laid directly on the prepared sub-base; it may be one or two courses. In the two-course method, a layer of concrete 3 to 4 in. thick is first placed. This concrete is of a mix, varying from 1:3½:7 to 1:2:4, a common proportion being one part cement, two and one-half parts sand and five parts crushed stone or gravel. After placing it should be thoroughly tamped and the top course placed immediately.

The top course is made of a rich mixture, with stone or gravel screenings for the coarse aggregate. A proportion commonly used is one part cement, one part sand, and one and a half parts stone screenings. Often a mixture of one part cement and two parts coarse sand is used with equally satisfactory results. The thickness of this course should be from 1 to 1½ in. The surface is then "floated "with a wood float, leaving it just rough enough to afford a good foothold, and is divided into squares. These squares may vary in size from 3 ft. × 3 ft. to 6 ft. × 6 ft., but should never exceed 36 sq. ft. in area. Care should be taken that the joints extend entirely through the pavement.

In the one-course method a 1:2:4 mix is used, the entire thickness of pavement being laid at once. This thickness may vary from 4 to 6 in., 5 in. being a common thickness. It is then finished and jointed as described above. One course construction is recommended, as it is less expensive, easier to lay, and not so liable to disintegrate as two-course work; besides, it is not so likely to be slippery, a common defect of two-course walks.

Where the walk meets the curb at street intersections expansion joints filled with a bituminous filler should be employed. Similar joints should be provided at intervals of 50 to 100 ft. along the walk. Coloring matter or lampblack is sometimes

added to the surface to take off the glare of natural concrete. Two pounds of lampblack to a barrel of cement will give the pavement a light slate color, and 16 pounds a dark bluish slate.

A concrete walk constructed as outlined above will prove entirely satisfactory. Failures of concrete walks are usually due to skimping of materials, poor workmanship, or inadequate provision for contraction and expansion and drainage.

Brick Walks.—Brick walks are laid in some localities, dark red building brick being ordinarily used. The foundation is prepared in the same manner as for concrete walks. About 2 in. of clean sand is spread on the base, and the brick laid on side either at right angles to the line of the walk or in a herringbone pattern. The brick are then sprinkled with sand and then tamped under a plank, or with a broad-surfaced wooden rammer. Sand is then swept into the joints. Brick sidewalks have a tendency to become uneven, and are more difficult to keep clean than cement concrete.

Miscellaneous Types.—Slabs of granite or sandstone are still occasionally used in some localities, but their use is being rapidly superseded by concrete. They are expensive, unless local material is available, and it is difficult to prevent unevenness at the joints, by settlement. They also frequently spall and break.

In New England tar concrete is quite extensively used. This type of walk is built in two courses. The lower course consists of about 4 in. of coarse gravel, thoroughly coated with tar. The wearing course is of coarse sand and tar, mixed hot, laid about 1 in. thick. Each course is tamped and rolled as soon as laid. The walk is covered with a thin layer of sand as soon as completed. These walks are not very satisfactory and are being replaced today by cement concrete.

A type of walk known as asphalt mastic has been used in France and to some extent in certain localities in this country. A mastic is prepared from a combination of rock asphalt and a refined asphalt, fluxed with an asphaltic base petroleum. Sufficient fluxed asphalt is mixed with the ground rock asphalt to give about 20 per cent. of bitumen, and a layer of this mixture about 1 in. thick is placed on a 4 to 6-in. concrete base. A small amount of fine gravel or coarse sand is then rolled into the surface of the warm material. This form of walk has been used quite extensively in at least one large American city, for walks over side-

walk basements, on bridges and in parks and apparently has given very good results. The life of the wearing surface is not as great as cement concrete, but is easier to walk on and the cost, including base, in the instance cited was about the same as that of cement concrete.

Sheet asphalt surface, similar in many respects to sheet asphalt paving has been used in parks and residential districts but is not as durable as the mastic or other types already mentioned.

Bituminous macadam walks constructed similar to bituminous macadam pavements, although much thinner have been used in a few cases but these are not very satisfactory due to uneven wear and settlement.

Asphalt tile walks, consisting of tiles or blocks of compressed asphalt and mineral aggregate, laid with or without a concrete base, have been used in New York and Boston parks and elsewhere but have not found general use in smaller towns and cities.

Where it is necessary to keep costs down to the lowest possible point, cinder, gravel or slag walks may at times be built. They are cheap and give fairly satisfactory results, and later on may serve as the foundation of a permanent pavement. The principal objections are difficulty in cleaning and in snow and ice removal.

Clean, coarse cinders should be used. They should be placed in layers, wetted and tamped. The total thickness may vary from 6 to 12 in., depending on the character of the subsoil.

Curbs and Gutters.—Curbs are built to form the backs of gutters and to protect sidewalks or planting spaces from the encroachment of vehicles. They must be of sufficient strength to resist the overturning thrust of the sidewalk or frost action, and sufficiently strong and tough to withstand the shock and abrasion of steel tires. Curbing is made of cement concrete, granite, limestone or sandstone. Of these, cement concrete is now the most widely used, the materials being universally available, the cost comparatively low, and concrete being easily adaptable to various conditions.

Stone Curbs.—Stone curbs are usually 4 to 8 in. wide and 12 to 20 in. deep. The projection of the curb above the gutter may be from 4 to 8 in., 6 in. being the standard in most places. Shallow stone curbs are usually set in a 6-in. bed of concrete. Deep curbs should be set on broken stone or gravel foundations, unless the subsoil is naturally well drained.

The top and exposed face should be dressed to plane surfaces, and the joints and other faces should be pointed, so as to permit close joints between the individual stones and between the curb and sidewalk pavement or gutter. Stone curbs are expensive, unless local stone of the proper quality is available, and do not give as good appearance as concrete.

Combined Concrete Curbs and Gutters.—Concrete curbs are usually built in place, using a concrete mixture similar to that used for sidewalks. The practice of surfacing the exposed faces with mortar has been generally used, but to an increasing extent, some curbs are now poured in one piece, omitting the mortar surfacing. Steel forms are much better than wood, as they are more economical and give a much better line and surface to the concrete, requiring less finishing. Concrete curbs are usually 5 to 6 in. wide, 18 to 24 in. deep, with joints spaced 6 to 12 ft. apart. They are built in the trench on compacted gravel, stone or cinders, or on an underdrain as described in an earlier part of this chapter.

The combined curb and gutter has come into favor on account of its cheapness and attractive appearance. A typical design of this is shown in Fig. 18. This design gives a pleasing appearance, does not cause damage to automobile tires, and actually adds to the effective width of the street, by cutting down the space required for parking, as the motorist is not afraid to drive close to it.

Gutters.—When the integral concrete curb and gutter is not used, gutters of flag-stones, brick, stone block and concrete are commonly built. Gutters should always be built on a paved street and especially on steep grades or fills where washouts are liable. On paved streets the gutter should have a shallow depth and the cross-section should conform to the finished pavement and the gutter need not be more than 2 ft. wide. On unpaved streets or macadam streets, the gutter should be deeper and wider, as wide as 36 in. having been used, in order that the gutter will carry all the water and thereby prevent washing of the roadway along the sides.

Flag stone gutters laid in a sand cushion may be the cheapest. Brick gutters may be built in the same way, but they are not entirely satisfactory unless a concrete base is employed. Stone blocks have been frequently used in the past, but all these types are rapidly being superseded by concrete for residential

developments. Concrete gutters are extensively used where curbs are built of stone or separate concrete section. They are used more extensively than brick on unpaved or macadam streets as they can be more easily shaped to the required section and will not loosen up as quickly as brick when not supported by the pavement backing. They are usually about 6 in. thick and built similar to a one course concrete roadway paving.

In suburban sections, where it is desired to avoid the use of a curb, the type of gutter shown in Fig. 19, has often been used with very satisfactory results, from the standpoints of economy and utility. When a wide planting strip is used, this gutter gives a very pleasing park-like appearance to the street.

Maintenance and Repairs.—*Cleaning.*—Street cleaning may be preventive as well as corrective, and the former may well be the more important. Preventive street cleaning may be carried out at small cost by the enforcement of local ordinances forbidding such things as sweeping of rubbish, paper and the like on the streets; disposal of this material in dumps where it may be scattered by the wind; storing of material on the highway by builders unless properly supervised; and failure to use proper receptacles for ashes, garbage and rubbish. These things are of major importance. The sanitary condition of a community is affected by the cleanliness of the streets, and this item should not be neglected.

Corrective street cleaning in industrial communities will usually be carried out by one or more men assigned to it, possibly combining this work with other duties. Police officers should be instructed to report promptly any violation of ordinances. When hard surfaced pavements are built, this should be supplemented by periodical flushings with a hose or power flushing machine. The condition of the pavements and the character of traffic attracted by the streets is also influenced to a marked degree by their cleanliness.

Repairs.—It cannot be too strongly emphasized that no pavement will give satisfactory service unless properly maintained. The amount of maintenance required for the different types of surfacings varies widely, but even for the more permanent types some work is necessary every year if the best results are to be obtained. It is very important also that breaks or holes in

the pavement should be repaired promptly, otherwise delay will mean multiple expense.

Expansion joints should be cleaned and refilled, cracks should be filled with bituminous material, holes and depressions should be repaired. It should be noted that holes should never be filled with harder material than that which makes up the rest of the pavement, as the final result of this practice will be two holes instead of one, or a little later, a hump in the pavement.

In conclusion it is pointed out that as are the streets, so is the town. A poor town never has good streets, and a good town seldom has poor ones.

CHAPTER VI

WATER SUPPLY

QUANTITY OF WATER REQUIRED—STANDARDS OF QUALITY—SELECTION OF SOURCE OF SUPPLY—PURIFICATION SYSTEMS—DISTRIBUTION OF WATER—PIPING SYSTEM—CONTRACT PLANS AND SPECIFICATIONS—FINANCIAL

Preface.—Water is a prime requisite to existence,—therefore, before the site for a housing development is finally chosen, an adequate supply of pure, potable water should be assured within a reasonable distance of the future community.

The most important use of a public water supply is that of furnishing water for domestic use, including that used for drinking and culinary purposes, for washing, showers, lavatories, and flushing closets. The essential requirements for such a supply are: first, quality which is of fundamental importance; next, adequacy, dependability and reasonableness of cost.

Second in importance is the use of water for fire extinguishment, the chief requisites being quantity, pressure and dependability. The third use is that for public requirements, among which are street cleaning, sewer flushing, street sprinkling and all water used by public institutions. The fourth use is for industry. The primary requirements of a water for these purposes are quantity and dependability.

QUANTITY OF WATER REQUIRED

Influences Affecting Consumption.—*Metering.*—It is probable that the most important factor in determining the consumption is whether the water is sold by measure or otherwise. The general tendency of metering is to reduce, to a large extent, unnecessary waste and, therefore, the installation of meters in industrial villages and housing developments is to be strongly recommended.

The marked reduction in consumption following the installation of meters in various cities is shown in Fig. 21. This relation between metering and consumption is presented in the form of

the per cent. that metering in various amounts reduces the use of water. The data are based on records of use in 85 American cities.

Detection of Leakage and Waste.—Another factor, almost as important as metering in its effect on consumption, is the care

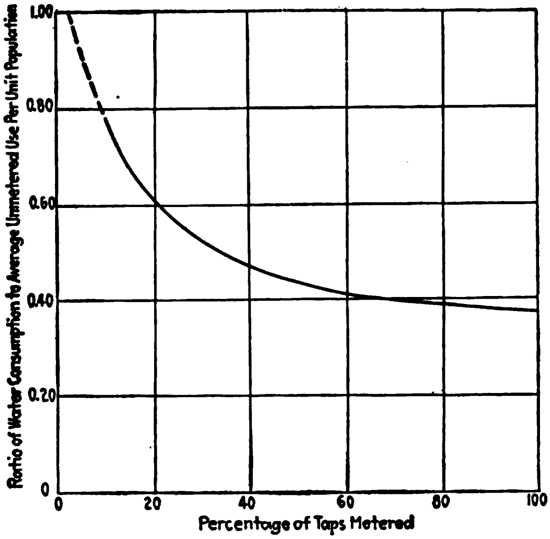

FIG. 21.—Effect of metering on the use of water.

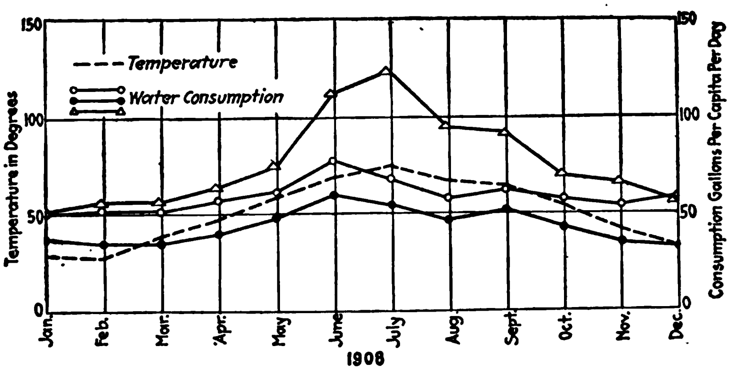

FIG. 22.—Effect of summer temperature on the per capita water consumption in thoroughly metered cities; 1908.

used in the avoidance of leakage and waste. Leaks in mains and services cannot be entirely eliminated. It would be next to impossible to find many of the smaller ones and even if located it would not pay to uncover the pipes and repair them. The

larger leaks, however, can, by the exercise of care in conducting leakage tests, be located and stopped; thus one of the most important items of waste can be eliminated.

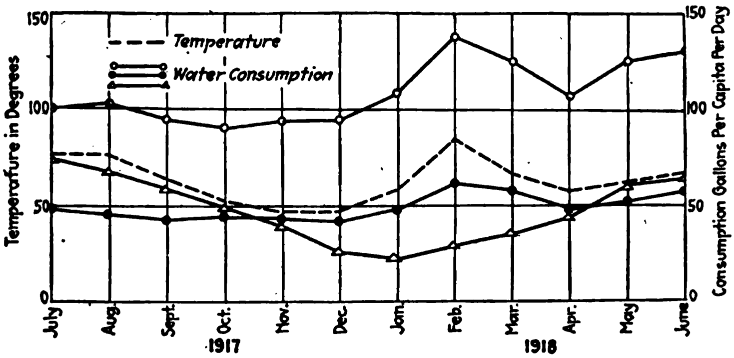

FIG. 23.—Effect of winter temperature on the per capita water consumption in highly metered cities; 1917–18.

Milwaukee, in 1916, had reduced leakage by care in detecting and stopping waste to approximately 17 gallons per capita per day; and Cleveland, in 1914, reported also a reduction to about 11 gallons per capita.

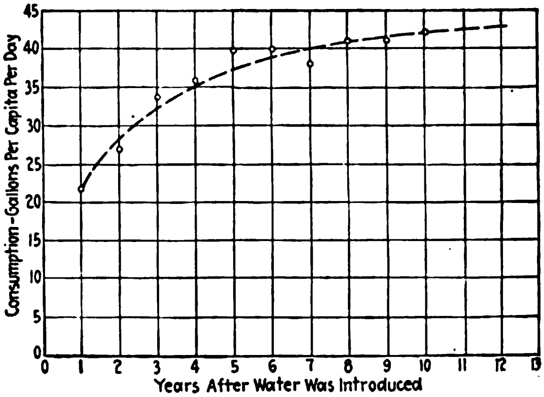

FIG. 24.—Relation between the age of water works and the daily per capita consumption.

Other Factors.—The wealth and habits of the people have a more or less indefinite but nevertheless direct bearing on the question of consumption. Climate also has a very considerable influence, especially upon the amount used for lawn and street

sprinkling and public purposes and that which is used to prevent freezing. The effect of high and low temperature is shown on Figs. 22 and 23, covering the period of high temperature in 1908 and the cold winter of 1917–1918, respectively.

The age of the water supply and the piping system exerts a considerable influence on consumption. As the consumers become more and more accustomed to the comvenience and uses of an abundant supply, they indulge in a more liberal use and often at the same time, in greater wastefulness. Age of street mains and services plays its part in contributing to opportunities for leakage by deterioration at joints, connections and in pipes themselves. The typical effect of age of service on water consumption is shown for a large number of towns on Fig. 24 herewith.

Consumption of Water for Various Purposes.—*Domestic Use.*—The consumption of water for domestic purposes varies between wide limits, dependent upon the type of town served and upon the class of houses. The average domestic use in various cities is given below, showing the wide variation in quantity of water used.

Table 15.—Consumption per Capita for Domestic Purposes, as Determined by Meter Measurements

City	Consumption gallons per day	Remarks
Boston, Mass.	16.6–59.0	Residential
Brookline, Mass.	44.3	Residential
Newton, Mass.	26.5	Residential
Belmont, Mass.	17.7	Residential
Malden, Mass.	19.6	Residential
Milton, Mass.	16.8	Residential
Watertown, Mass	15.3	Residential
Fall River, Mass.	11.2	Manufacturing
Worcester, Mass.	16.8	Manufacturing
Yonkers, N. Y.	20.6	Manufacturing

The variations in domestic consumption corresponding with various types of houses are shown in the records of the Metropolitan Water District of Boston, Mass.[1] given in Table 16.

Commercial Use.—Under this head, there should be included all uses for mechanical, trade and manufacturing purposes. Large

[1] Jl. N. E. W. W. Assoc., Vol. 27, P. 56.

TABLE 16.—WATER CONSUMPTION IN DWELLINGS OF DIFFERENT CLASSES IN THE METROPOLITAN WATER DISTRICT BOSTON, MASS.—1908

Kind of houses	Number	Estimated population	Consumption in gallons per capita per day
Single (including some stables and garages)	8	37	140.9
2 family	5	48	37.5
3 family	9	129	61.2
4 family	20	382	29.5
5 family	25	598	76.2
6 family	36	1,032	52.2
7 family	31	1,037	35.5
8 family	278	10,631	28.0
9 family	86	3,700	27.5
10 family	65	3,107	50.3
11 to 20 family	113	7,849	35.3
21 to 30 family	18	2,199	44.3
Over 30 family	9	1,640	25.1
Combined house and store	505	21,410	29.9
Total	1,208	53,799	Average 33.0

amounts of water are used in office buildings, stores, hotels, factories, elevators and railroads. The use for these purposes varies greatly in different communities. In 1902, it varied from 12 to 46 gal. per capita in large American cities. In small housing developments, however, the amount of water used for such purposes is relatively small and it probably is fair to estimate the consumption for commercial purposes at from 5 to 20 gal. per capita, depending on local conditions.

TABLE 17.—WATER USED FOR PUBLIC PURPOSES—BOSTON METROPOLITAN DISTRICT IN 1902

Use	Gallons per capita per day
Public buildings	3.8
Drinking and ornamental fountains	1.0
Street sprinkling	2.1
Flushing pipes and extinguishing fires	0.2
	7.1

Public Use.—Water used for schools and other public buildings, street sprinkling, sewer and water main flushing, fire extinguishment and other occasional uses comes under this classification. In the Boston Metropolitan Water District, water was used, in 1902, as shown in Table 17.

It is difficult to make a close estimate of the quantity used for flushing water pipes and sewers and for extinguishing fires. Although large quantities are used occasionally for these purposes, the total quantity consumed during a year is comparatively small. An allowance of 5 to 7 gal. per capita for public use will, in most cases, prove ample.

Loss and Waste.—The enormous quantities of water used by some of the large cities of the United States, when compared with the actual metered use, indicate that a very large percentage of the water furnished is lost through leakage or is wasted by the consumer. Even in highly metered communities the percent of water pumped which is not accounted for may easily equal from 30 to 50 per cent. of the total consumption, as is shown in Table 18.

TABLE 18.—USE OF WATER AND PERCENTAGE UNACCOUNTED FOR IN WELL METERED CITIES[1]

City	Per cent. of taps metered	Consumption per capita gallons	Per cent. not accounted for
Brockton, Mass.	100	34	30
Cleveland, Ohio	49	96	21
Englewood, N. J.	100	..	52
Fall River, Mass.	100	37	13
Hackensack, N. J.	100	..	40
Lawrence, Mass.	92	46	39
Ridgefield, N. J.	100	163	18
Ware, Mass.	100	44	39
Wellesley, Mass.	100	52	43
West Orange, N. J.	100	..	20
Yonkers, N. Y.	100	83	17

[1] 1906, J. H. Fuertes; with revisions.

According to the State Department of Health of Massachusetts, in 1900, no city of that state, having over 90 per cent. of taps metered, accounts for over 62 per cent. of the water furnished; while one fully metered city finds but 37 per cent. of its supply registered by such devices.

The water lost through waste and leakage may be divided into two general classes:—that lost by leaks in the main pipes and distribution system, and that lost on the premises of the consumer through leaks in service pipes and plumbing. The amount of leakage from these sources is dependent upon the care used in laying the pipe and the effort made to locate and repair leaks. All in turn are more or less dependent upon the total length of lines to be maintained. This relation is amply demonstrated by Fig. 25, based upon records of 14 well metered cities.

Loss from well constructed distribution systems of 2,500 to 3,000 gal. per day per mile was deduced by Emil Kuichling.[1] It is probable that leakage in a new system will not be materially

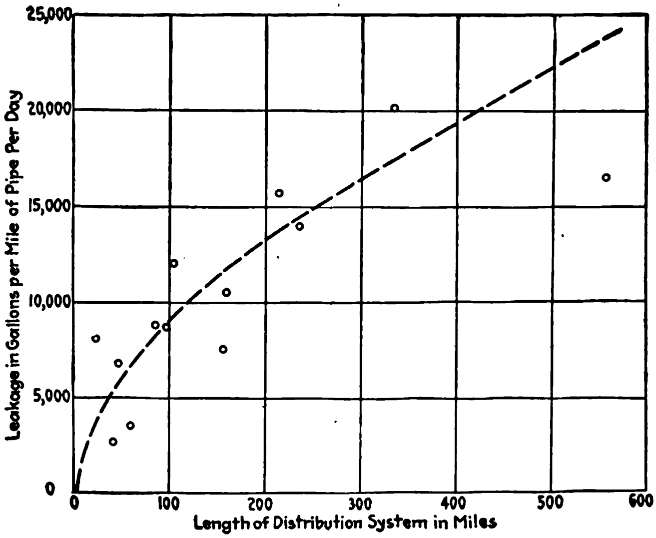

Fig. 25.—Leakage and waste of water in thoroughly metered cities.

less than 3,000 gal. per mile daily, unless special care is used in testing and all defects remedied. In new work, 200 to 250 gal. daily per mile per inch of diameter of pipe probably represents the permissible leakage, and it is likely to run higher.

Total Consumption.—In the case of a new supply, where the immediate installation of meters is not contemplated, a daily quantity of not less than 100 gallons per capita should be provided for, based upon the approximate quantities shown in Table 19.

[1] Trans. Am. Soc. C. E., Vol. 38.

TABLE 19.—AVERAGE CONSUMPTION IN UNMETERED CITIES

Types for use	Gallons per capita per day		
	Minimum	Maximum	Average
Domestic	30	80	50
Commercial	5	30	15
Public	3	10	5
Loss	20	35	30
Total	58	155	100

Should the supply be metered, the average per capita consumption might be reduced to 50 or 75 gal., most of the reduction coming in the domestic and commercial classes.

Variations in Consumption.—The probable maximum consumption which must be provided for depends almost wholly on local conditions. The average variation in use of water, based on records of 67 Massachusetts cities, is shown in Table 20.

TABLE 20.—MAXIMUM WATER CONSUMPTION BASED ON AVERAGE OF 67 MASSACHUSETTS CITIES AND TOWNS[1]

	Gallons per capita per day	Per cent. of yearly average
Average daily for the year	63	100
Maximum month	81	128
Maximum week	93	147
Maximum daily use of water	123	198

[1] Jl. N.E.W.W. Assoc., Vol. 27, p. 9[illegible].

Although in exceptional cases the maximum daily consumption may equal 300 per cent. of the average, the figures quoted above may be taken as representative of general conditions. The hourly demand rate, however, which may occur twice a day may very likely be as high as 300 per cent. of the average daily.

STANDARDS OF QUALITY

General.—Those qualities which distinguish a good "safe" water may be summed up in a negative way as follows:

First: The water should be free from bacterial contamination, sewage pollution and all other waste products.

Second: It should not contain an excessive amount of mineral matter.

Third: It should be free from color, odor, taste and suspended matter, and preferably should be delivered at a temperature of not over 60 degrees Fahrenheit.

Sanitary Quality.—*U. S. Treasury Standard.*—The standard adopted by the United States Treasury Department, in determining the allowable limits of contamination, are briefly: the 37°C. bacteriological count on nutrient agar at 24 hours, shall not exceed 100 per c.c.; and that not more than one out of five 10 c.c. samples of the water shall show the presence of Bacillus Coli.

Classification of Great Lakes Water.—The progress report of the International Joint Commission, covering its investigation of the Pollution of Boundary Waters, contains the sanitary classification given in Table 21.

TABLE 21.—CLASSIFICATION OF GREAT LAKES WATERS[1]

Classification	Bacillus Coli per 100 cubic centimeters	Total bacteria on agar at 37° Centigrade per cubic centimeter
Unpolluted	Less than 2	Less than 10
Slight pollution	2 to 10	10 to 25
Considerable pollution	10 to 20	25 to 50
Serious pollution	20 to 50	50 to 100
Gross pollution	Over 50	Over 100

[1] Progress Report, International Joint Commission on Pollution of Boundary Waters, June 16, 1914, p. 20.

General Standard.—The sanitary standard as to B. Coli, as required by the U. S. Treasury Department is extremely severe and is difficult and generally considered impossible of continuous attainment in ordinary water works practice. General practice appears to permit 50 to 75 total bacteria per c.c. at 37°C. and 2 to 5 Bacilli Coli per 100 c.c. sample, subject to restriction, however, when considered in conjunction with each other and a knowledge of the condition of the source of supply.

Physical Quality.—*Color.*—The allowable concentration of color in a water supply is subject to wide limits in different localities, due to differences in custom and habits. In general, in the East and particularly in New England, where highly colored

waters are common, an amber color of 20 parts per million is not objectionable; while in Central and Western United States, a color of even 10 parts per million would not be tolerated.

Turbidity.—The reverse is true of turbidity, since in the West, waters of 100 parts per million turbidity are frequently countenanced; while in the East, a water with a turbidity of over 20 parts per million would not be allowed. However, the tendency in modern water supply practice is everywhere toward a clear, brilliant and sparkling water.

Odor.—There is universal repugnance against drinking water with an odor. A very faint odor, as listed in standard classifications, is not particularly noticeable, but the number of objecting consumers increases rapidly when forced to use a water of a faint to decided odor.

Chemical Quality.—The characteristics of a "good" water from a chemical standpoint are given in Table 20.

TABLE 22.—ALLOWABLE ORGANIC AND MINERAL CONSTITUENTS IN GOOD WATER[1]

In Parts per Million

Constituent	Allowable quantities	
	Surface water	Ground water
Organic Content		
Albuminoid ammonia	0.15	0.4
Free ammonia	0.15	0.2
Nitrites	0.01	0.02
Dissolved oxygen	Not less than 40 per cent. saturation	
Mineral Content		
Chlorine	1 to 10 parts above normal	
Iron	0.1 to 0.5 according to condition	
Hardness	Dependent on locality	
Alkalinity	Not less than 10 parts per million	
Sulphates	Not more than 60 parts per million	

[1] Woodman-Norton; Air, Water and Food, 1914, pp. 56–68.

Organic.—The ammonias and nitrites are indices of recent pollution and therefore their presence, even in minute quantities, casts suspicion on the source of supply. Nitrates, however, indicate past pollution except in deep ground waters, with always the possibility of renewed pollution in the future. Their presence, *per se*, is not sufficient cause for condemnation, particularly in a supply wholly from subsurface sources.

The lack of oxygen dissolved in a water indicates organic matter has been or is present in a decomposed form, which is using up the oxygen in the water for its oxidization. Water which is less than 40 per cent. saturated with oxygen should be condemned as unfit for use.

Mineral.—The presence of iron in a supply is objectionable, because of the stains imparted to clothing in laundering, or to fixtures or utensils, as well as to the unpleasant metallic tastes when present in quantity.

Chlorine is found in all natural waters. Its source may be salt deposits in the soil, or sea salt carried inland from the sea by wind, precipitated with the rain. Where the normal chlorine is known, an excess, in the absence of soil deposits, is a sure indication of pollution.

The allowable hardness, like color and turbidity, depends on the location of the supply. In Eastern United States, waters with a hardness of 50 parts per million are rare, while in the West 300 parts of hardness is not uncommon. In general, however, 10 parts per million of hardness characterizes a soft water, 25 to 30 parts an average water, 50 parts and over a hard water, and a hardness of 150 parts per million or more is said to be "excessive."

The chief objection of the domestic consumer to excessive hardness is the amount of soap required to soften the water—eight parts of soap being required to counteract one part of hardness. Where the hardness is less than 10 parts per million, however, considerable trouble is experienced from the corrosive action of the CO_2 in the water on the plumbing fixtures. The most desirable water for general use contains not less than 10 or more than 30 parts per million of hardness.

Alkalinity and sulphates are indices of particular value in the coal mining regions, where water may be contaminated by mine drainage.

SELECTION OF SOURCE OF SUPPLY

Extensions of Existing Supply.—*Quantity.*—In most instances, housing developments are constructed either adjacent to or near existing cities or towns; so that connections to the existing utilities can be economically made. In extending the existing water supply to embrace the new community, it is desirable, before entering into contractual relations with the water works organization, to be assured that the water plant already existing, or to be enlarged, can, in addition to the supply of the present population, take on the additional population of the housing development.

The existing community should be content to be supplied, in all probability, at the rate of use already established (if reasonable). The additional population will be supplied at the amounts previously discussed and dependent upon character of service and allowance for habits and use.

Quality.—Water furnished to a housing development from an adjacent system should at all times correspond and be in accordance with the sanitary, physical and chemical requirements previously set forth. To this end, laboratory control and checks should be made from time to time, if not already introduced, to assure continued purity and safety.

In case the water is drawn from a surface supply unfiltered or unprotected, the installation of filtration or sterilization, or both, should be strongly urged. Such may be an absolute necessity if there be visible contamination. Coöperation with the local health authorities should be sought, to enforce the adoption of proper safeguarding measures.

In general, waters from deep artesian wells, or from carefully developed ground water supplies in their natural state are acceptable, if protected, and provided the mineral content is satisfactory.

Pressure.—Where extension of existing water supplies is necessary, it is desirable to have some reasonable standard of pressure. While housing developments are largely residential, high business or other public buildings may occur and proper fire protection should be provided therefor.

In general, 40 pounds per sq. in. is the minimum domestic fire pressure that should be provided in mains. This is further discussed under the subject of "Distribution of Water."

Where fire pressures are now maintained by fire service pumps, ample and duplicate pumping machinery should be present.

New Supply System.—Where a water supply necessitates the development of new sources, problems arise in the consideration of this important subject which are extremely complex and deeply technical, involving the sciences of bacteriology, chemistry, hydraulics and engineering. The same questions of quantity and quality arise as in the consideration of an existing system. It is intended here to point out, only, the various factors affecting the choice of a source of supply; together with general principles concerning the requisite size of works to adequately care for the present demands for water and also such increase as may be required by the future growth of the development.

The two main divisions into which water supplies may be separated are ground water supplies and surface supplies. It is unusual that both a ground and surface supply, capable of full development, are available. Should such a situation arise, the choice of the most suitable supply may be determined readily by a comparative estimate of the first cost, annual charges of each development and a study of the relative advantages and disadvantages.

Ground Water Supplies.—To procure water economically in the large quantities required for public supplies from a well system, there must be present a water-bearing formation of considerable extent and porosity. The location of such a deposit cannot readily be determined from surface indications, but requires either an extensive study of the geological strata underlying the well site, coupled with borings and tests; or the random sinking of wells in various localities, with properly conducted pump tests, which is a rather expensive experiment. In many localities, considerable data on water-bearing strata have been collected by the United States Geological Survey and various state agencies, which are available for public use, and are a valuable aid in selecting a possible site for a well field.

A favorable location for a well plant will be at a point where the ground water is reached with the least lift of the pumps. This will ordinarily be on low ground and often in the vicinity of surface streams. If wells thus placed are pumped too low, they may draw water from the stream as well as from the ground water, a result sometimes undesirable, particularly when such a stream is polluted.

The best method of estimating the capacity of a well field is by means of actual pumping tests carried on for a sufficient length

of time to bring about an approximate state of equilibrium between the supply and demand, as determined by the status of the ground water level. Pumping tests of short duration are apt to be very deceptive, since the source may be an underground basin or reservoir with very little movement, corresponding to a surface pond with small watershed. An approximate idea of the amount of water actually flowing per unit of time through the area in question may be had by estimating the velocity of flow, by means of electrical and salt tests, the cross section of the porous stratum, and the percentage of porous space; or by estimating the probable percolation on the tributary area.

The bacteriological quality of ground waters is in general excellent, where proper precautions are taken to prevent contamination by surface water from too close proximity of polluted sources. The water passing through the soil layers, which act as a natural filter, usually renders the water in deep wells quite satisfactory. On the other hand, the percolating water, by virtue of contained carbon dioxide obtained from the air, dissolves large quantities of both organic and inorganic salts, often rendering the water unfit for use on account of excessive hardness, or high content of iron or manganese. In the presence of humus and absence of oxygen, the sulphates may be reduced to hydrogen sulphide and the nitrogen compounds to ammonia, thereby rendering the water nauseous. Ordinarily the quality of ground water is impaired by storage.

Where the hardness of the subsurface waters is excessive, as is likely to be the case in the limestone regions of the central states, softening treatment by means of chemicals and filtration may be prerequisite. In the majority of cases, however, no form of purification other than aeration and perhaps subsequent settling is required with a ground water supply,—an item of considerable importance when compared with a surface supply. This advantage is somewhat affected, however, by the fact that with a well supply, pumping is invariably necessary, usually requiring two sets of pumps to lift the water from the ground to the distribution system; while with a surface supply it is sometimes possible to obtain a gravity supply requiring no pumping at all.

Surface Water Supplies.—When a stream is under consideration as a source of water supply, the peculiarities of its flow—the minimum, maximum and total flow for various periods of time—

are among the first things to be determined. The most accurate and direct method of determining these is by means of careful gagings extending over several years; which, to be of the greatest value, must include periods of high flood and periods of drought. The United States Geological Survey, in coöperation with various States Commissions, maintains gaging stations on most of the principal streams in the United States, with records available to the public.

Where gagings are not available, or where they are very limited in extent, estimates must be made from rainfall records, absorption and run-off, and from a comparison with other streams whose flows are known.

The dry weather flow of streams is maintained entirely from ground and surface storage; and as facilities for such storage vary in different watersheds, so will the minimum flows be unlike. For streams in the Atlantic Coast States, records indicate that, for watersheds of less than 200 sq. mi. in area, the minimum flow varies from nearly 0.05 to about 0.2 second feet per square mile, averaging 0.10 or 0.12. In the upper Mississippi Valley the minimum flow of streams is much less, and it sometimes becomes zero for watersheds of several hundred square miles drainage area, while further west the same is true of much larger streams. In general, to supply a population of 5,000 persons, a drainage area, without artificial storage, of 10 to 40 sq. mi. will be required.

Naturally the availability of running streams has led to their adoption as sources of water supply more frequently than any other kind of surface water; but it must be remembered that this is not because they are of better quality. The use of surface waters, particularly those of flowing streams in densely populated watersheds, is a menace to public health, unless they are first subjected to some method of artificial purification.

Wherever the minimum rate of yield of a source of water supply is less than the demand, the excess of demand over supply may often be provided for by storing the surplus waters during periods of greater yields in impounding reservoirs. Such reservoirs are usually formed by constructing a dam across the valley of the stream. Natural ponds or lakes, however, can frequently be used as reservoirs. The value of ponds or lakes for storage will depend upon the available (net) storage or amount the surface can be varied in elevation, and not upon their total capacity.

The safe yield is based upon considerations of rainfall, run-off

and storage; or, if the run-off is not available, upon like data for a similar drainage area properly weighed for local conditions. Considerable study has been given to the yield of watersheds in New England, and some elsewhere on large supplies, and experience shows that only small storage is necessary to obtain 200,000 to 300,000 gal. daily per square mile, but for larger yields much larger relative storage must be provided. In general, the storage which will be required to supply a constant draft of 100,000 gal. daily per square mile from a given area will vary between 10 and 35 mil. gal. per square mile, in the Eastern and Central parts of the United States, while in the West and South a much greater quantity is required. It is generally found inexpedient to attempt to secure more than 80 per cent. of the average run-off; or develop more than 500,000 gallons per square mile of drainage area. Swamp lands detract from the storage value of a watershed, as they promote evaporation.

Having decided upon the area which may be available, the next step is to select a suitable reservoir site. The location is largely determined by the distance of the reservoir from, and elevation above, the point of distribution. Long distances require heavy expenditures for conduits or pipe lines, but these expenditures are relatively less the larger the quantity of water furnished. For larger communities, it will be practicable to go much further for water than for small cities. It is desirable that the reservoir shall be at sufficient elevation to enable all or at least a part of the consumers to be served by gravity alone, and it will be economy to spend a realtively large sum of money for conduits to secure this advantage. The size of conduits conducting water from the source of supply to the point of distribution should be such as to deliver the requisite quantity of water without undue loss of head.

The same remarks regarding quality of surface waters apply as in the previous discussion; but, in the case of large impounded supplies, considerable purification takes place in the reservoir itself. In the storage of surface waters, sedimentation is effecive in eliminating much of the suspended matter, including living organisms as well as a portion of the organic matter. Where considerable mineral matter is in suspension, as in many rivers especially during flood seasons, the degree of purification by subsidence is even greater than where the suspended solids are less. The color of waters, especially when due to organic mat-

ter, is lessened by storage, although the bleaching action of the sun's rays does not extend rapidly to great depths. In general, about 10 to 30 per cent. reduction in color may be expected. The watershed should be subject to strict sanitary inspection and supervision, and even where filtration is not necessary, some type of sterilization apparatus, such as that employing liquid chlorine, should be installed for emergency use.

Summary of Factors Affecting Choice of Supply.—Where a housing development is adjacent to a city, there is little choice in the selection of a source of supply, since it is usually cheaper to obtain water by the extension of the city system. Where a new supply must be sought, the choice between a ground water supply and a surface supply is usually dependent upon the availability or the existence of such supplies.

The quantity of water available is perhaps the most potent factor in the choice of supply. The size of tributary watershed of a surface supply, or the extent of the water-bearing stratum for a ground water supply, is of fundamental importance, since it determines the possibility of economical future extensions to the supply. The cost of development of a surface water supply, by the construction of impounding reservoirs, is usually prohibitive for a small housing development; so that unless the watershed of a natural stream near the site is of sufficient size to supply the requisite quantity of water without impounding, the development of a ground water supply if available will usually be found most economical.

Concerning the relative quality of supplies, a clear, soft, cool, ground water supply of known purity is most acceptable. Where such is not available, the relative costs of a distant unpolluted or an adjacent contaminated supply must be fully weighed. The cost of softening or removing iron must be taken into account in considering alternate supplies.

A gravity supply, even for a portion of the total housing development, is very desirable, since the cost of pumping even small quantities of water amounts to considerable.

PURIFICATION SYSTEMS

Preface.—The various processes of purification may be divided into two groups, (1) those for the removal of suspended impurities, and (2) those for the removal of dissolved impurities.

Of the first class there are two general processes, sedimentation and filtration, both of which may be called natural processes. In the second class are the removal of dissolved impurities by coagulation or aeration, usually involving subsequent sedimentation or filtration for the removal of the precipitate.

Other methods of purification are by distillation, in which practically all impurities are removed, and the various methods of sterilization, in which the bacteria are simply destroyed.

It will readily be seen that each problem in water purification demands individual treatment; and that the best method to adopt in any case will depend upon the character of the water, the use to which it is to be put, and the relative costs of the various treatments. No one process is universally applicable; furthermore, of two processes for removing the same kind of impurity, the most efficient may not in all cases be the best. The highest efficiency is not always necessary, and in such cases economy may properly be secured by the adoption of a system of less efficiency but of lower cost.

Plain Sedimentation.—Plain subsidence, or sedimentation, is adapted to the purification of a water containing a subsidable silt or clay. It is the cheapest method of removing particles which would clog an ordinary filter and which settle out in a moderately short time. The process is effected in open basins, with concrete floors, or in impounding reservoirs which are designed to hold from a few hours' to several day's supply. Cleaning is usually accomplished, in the case of artificial basins, by the use of hose streams which flush the sediment through specially designed drains. The size of sedimentation basins to effect the requisite subsidence is dependent mainly upon the size of particles to be removed and somewhat upon their specific gravity.

Results.—In general, well baffled basins without too great velocity having a capacity equal to 6 hours' flow, will remove particles less than 0.02 mm. in diameter; while a capacity equal to 24 hours' flow will remove particles less than 0.007 mm. Collodial suspended matter in clay-bearing streams cannot be removed even after weeks of sedimentation. The efficiency of sedimentation is a function of the area and of the specific gravity and shape of the particles.

Filtration.—The two principal classes of filters are "Slow Sand," or "English," and "Rapid Sand," or "Mechanical"

filters. Each is particularly adapted to the purification of certain types of water, both are used with preliminary sedimentation.

Slow Sand Filters.—For a water having a turbidity generally less than 50 parts per million, or a color less than 20 parts per million, slow sand filters, without coagulation, give excellent results. They consist of artificial sand-filter beds contained in masonry basins. The size of units is large compared with the rapid sand filter, each unit containing about one acre.

The influent containing impurities is applied to the top of the sand layer at a rate of 2 to 6 million gallons per acre per day, dependent upon the character of the water. The filter acts primarily as a strainer, the interstices between the sand grains being small and serving to stop all particles too large to pass through them. The effluent is drawn off the filter through a system of underdrains, constructed of tile pipe with open joints.

When the accumulation of impurities on top of the sand layer has become so great that the loss of head through the filter equals 3 to 4 ft., the filter is cleaned by scraping ½ in. to ¾ in. of sand from the top; a process which must be repeated every 1 to 3 months. About once a year the sand so removed is replaced after it has been washed and cleaned of gross impurities.

The bacteriological efficiency of the slow sand filter varies between 95 and 99 per cent. Some typical results are shown in Table 23 below.

TABLE 23.—BACTERIOLOGICAL EFFICIENCY OF SLOW SAND FILTER

Location	Year of record	Efficiency per cent.
Lawrence, Mass.		
Old filter	Ave.—1909–1916	97.5
New filter	Ave.—1909–1916	96.9
Washington, D. C.	Ave.—1907–1912	98.4
Albany, N. Y.	Ave.—1917–1918	95.6

About one-third of the color can be removed in the process of filtration, while 25 to 50 parts per million of turbidity can be successfully applied to the filter.

Rapid Sand Filters.—The chief use of the "Rapid Sand" or "Mechanical" filter is in the purification of waters having a turbidity of more than 50 parts per million or a color of more

than 30 parts per million. In contradistinction to the slow sand filter, the influent is applied to the sand layer at a rate of about 125 million gallons per acre per day, after addition of coagulating chemicals such as aluminum sulphate, or lime and iron. The size of sand particles is somewhat larger in the rapid than in the slow sand filter, their effective sizes being 0.45 to 0.50 mm. and 0.25 to 0.30 mm. respectively. The effluent is drawn off through a specially designed strainer-system, which also serves as an inlet to the wash water.

Washing the filter, which becomes necessary when the lost head equals 7 to 10 ft., or every 12 to 24 hrs., is accomplished by reversing the direction of flow through the filter. The "mat" on the surface is lifted by the rapid flow of water and is carried off through special gutters which connect with the sewer. The quantity of wash water required varies from 0.4 per cent. to 1.0 per cent. of the total quantity filtered. The filter "mat" in this case is formed by the flocculent precipitate resulting from the addition of chemicals prior to the filtration process.

The bacteriological efficiency of rapid sand filters is about the same as the slow sand type. Some typical results are shown in Table 24 below. These results are apparently higher than in the case of slow sand filters; however, the growth of bacteria in the underdrains of the latter reduces the apparent percentage removal.

TABLE 24.—BACTERIOLOGICAL EFFICIENCY OF RAPID SAND FILTERS

Location	Year of record	Efficiency per cent.
New Orleans, La.	Ave. 1909–1918	98.9
Columbus, Ohio	Ave. 1918	99.1
Cincinnati, Ohio	Ave. 1917–1918	99.8
Louisville, Ky	Ave. 1917	99.8

The removal of high color and turbidity is practically without limit, since it is dependent upon the addition of chemicals, the greater turbidity requiring more precipitant.

Coagulation.—The purposes of coagulation are to collect the fine suspended matter in the water into clots or masses of a size which will settle to the bottom of the sedimentation basins, and also to form a film over the filter sand preventing even the finest

suspended particles from passing through. Coagulation also assists in removing color, odors and tastes from the water.

The process of coagulation, principally used with rapid filtration, consists in the addition of salts of aluminum or iron to a water containing solutions of hydroxides, carbonates or bicarbonates of the alkalis or alkaline earths, thereby forming gelatinous precipitates of the hydroxides of the metals. As is commonly the case of solutions in water, such floc tends to form about the particles of silt, bacteria, etc., present in the water; and, uniting with other flakes of coagulum the masses thus formed, either settle to the bottom of the sedimentation basin or are finally caught on the filter surface. Coagulation with alum, without subsequent filtration is not to be recommended for a potable water supply.

Aluminum sulphate is very successful in removing color caused by the tannates and gallates in swamp water. 17 parts per million will remove about 10 parts per million of color. In the removal of turbidity the amount required depends on the fineness and amount of turbidity. Aluminum sulphate will react directly with the natural alkalinity of the water, if there is sufficient of the latter. Each part per million requires for complete reaction from 0.3 to 0.45 part per million of natural alkalinity, unless there be large amounts of organic matter. Deficiencies in alkalinity may be corrected by the addition of lime or soda ash.

The advantages of the use of ferrous sulphate over "alum" are:—the cost of treatment is generally cheaper, especially with very turbid waters; and the coagulum formed is of greater specific gravity than in the case of alum, causing a more rapid sedimentation. It cannot, however, well be used with colored swamp water.

Sterilization.—While properly treated and filtered water is practically free from bacteria, it has of late years become customary to treat the filtrate with a germicide as an additional precaution.

Hypochlorite of lime has been very extensively used for this purpose but is being replaced by the use of liquid chlorine. The latter is easier to control, more exact in application and is not so likely to cause tastes and odors. Sodium hypochlorite and ultra violet rays have been used to some extent. Ozone and copper sulphate have also been tried.

Hypochlorite exerts a destructive action on the bacteria in the water, readily destroying such pathological bacteria as B. Typhosus and the cholera spirillum. The bleach may be applied to the raw, settled or filtered water, but is least effectively applied to the raw water.

The germicidal effect of liquid chlorine results from the liberation of nascent oxygen in solutions as well as from its action as a specific germ poison.

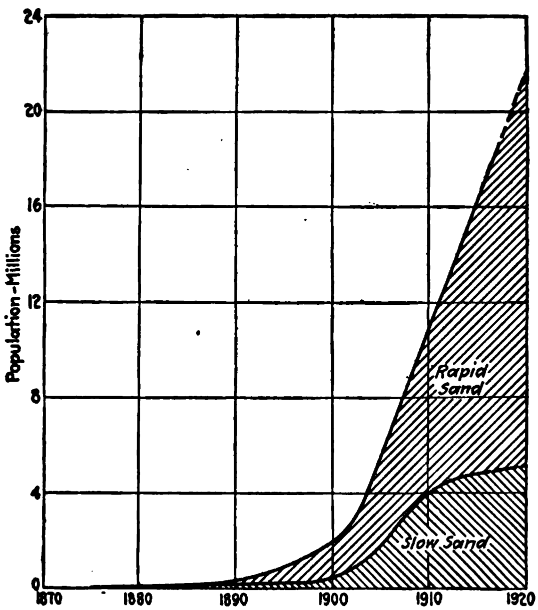

FIG. 26.—Growth of water filtration in the United States

Summary.—The constantly increasing pollution of sources of water supply is making necessary the purification of practically all supplies. The trend of the times appears to be toward the adoption of rapid sand filters for general purification. Fig. 26 herewith shows the increasing popularity of the rapid sand filters in the United States.

The various chemicals employed by 124 filtration plants in Pennsylvania is typical of plants throughout the country. A summary is shown below in Table 25.

Table 25.—Chemicals Used in Water Purification in Pennsylvania Based upon a Study of 124 Filtration Plants

Chemical employed	Number of plants employing chemicals
Sulphate of aluminum	102
Hydrated lime	20
Iron sulphate	4
Chlorinated lime	104
Chlorine gas	10
Sodium thiosulphate	1
Copper sulphate	1
None	3

DISTRIBUTION OF WATER

Pressure Requirements.—*Domestic Use.*—For domestic use, it is generally found that a minimum service pressure of 20 pounds per square inch on the top floor of a dwelling house will give a flow of water that is completely satisfactory. Where houses are not more than three stories in height, this means that a pressure of about 35 pounds at the street level is required. A pressure of 50 pounds per square inch at the curb would generally supply buildings six stories in height with satisfactory water pressures. Pressures of 75 to 100 pounds are required in business districts.

At the highest point in the development, pressures somewhat lower than the above limit may be permitted. In special instances of this kind, in strictly residence districts where water is not used above the second floor, pressures at the curb as low as 25 pounds per square inch have been and are used with reasonable results, provided the service pipe and inside plumbing are capacious enough.

Fire Service.—For fighting fires, where fire engines are used, the only demand upon the piping system is to supply water to the engines without requiring them to work under a suction lift. For this purpose, an actual pressure of 20 lb. per sq. in. at fire hydrants is as good as more, providing such a pressure be consistently maintained underdraft.

It is common practice in small systems to so arrange the pumping works that pressures in the distribution system may be raised temporarily during times of fire, thus avoiding the use of fire

engines. This subject of fire protection facilities is one fully covered under "Piping System".

Fire Protection.—*Value.*—The value of fire protection is not only shown in the lessened property damage, but is also evident in the decreased insurance rates resulting from the installation of adequate fire fighting facilities. Installation of better fire fighting facilities will bring about a reduction in rates of insurance, other things being equal.

Cost.—The cost of furnishing water for fire protection to property is out of all proportion to the amount of water used, for, while the cost of construction is greatly affected, the amount of water consumed is slight. The extra cost involved in furnishing adequate fire protection is due largely to increased pumping capacity, size of mains, reservoirs or standpipes, and to hydrants and connections.

Careful estimates place the proportion of interest, depreciation and fixed charges chargeable against fire protection at one-quarter to one-half of those of the entire water works system, inversely dependent upon the size. Comparative studies have shown that, except in a few of our largest cities, it is impracticable to maintain a separate high pressure distribution system for fire protection. However, cases may arise in housing developments where it is possible to secure a limited amount of pure water for domestic purposes and to supply water for fire purposes pumped directly from a polluted source; a dual system may thus prove economical and wise.

The use of horse or motor driven fire engines is usually more economical than the attempt to maintain high pressures throughout the combined domestic and fire service system.

Pumping Works.—*Design.*—Where water cannot be obtained at an elevation sufficient to produce a satisfactory gravity pressure at the points where it is to be used, it becomes necessary to provide a pumping plant for this purpose.

This design involves the selection of:

(1) Best source of energy for power purposes.

(2) Most economical means of generation and transmission.

(3) Type of pump best adapted for the conditions.

These factors are often largely affected by the nature of the source of water supply, and by various other features of the water works system.

Pumping units seldom operate at full normal capacity all the

time. Efficiency at half load is much less than at rated capacity; hence, the theoretical duty obtained on test is not a true measure of results which will be obtained in actual operation. A common error in the design of pumping stations is to subdivide the maximum total pumping capacity required into units of equal capacity. It is usual that a subdivision into different sizes will allow each unit to be operated at full capacity, and thus the result will be more economical than would otherwise be possible.

Reciprocating Pumps.—In pumps of this type, a piston or plunger (which is the displacing agency) reciprocates in a closed cylinder, provided with the necessary inlet and outlet valves, and alternately inspires and discharges the water from the chamber. Pumps of the piston type, owing to the facility with which the packing can be renewed, and the smaller clearance spaces in the pump cylinders, are particularly efficient for lifting water by suction, especially where it is impossible to prime the suction piping before starting the pump.

A comparison of the volume of water pumped and the theoretical displacement of the piston gives the loss of water due to "slippage." Few pumps operate with less than 4 to 5 per cent. "slip", while it is not unusual to find 10 to 30 per cent. The ordinary efficiency of reciprocating pumps varies from 60 to 85 per cent.

Centrifugal Pumps.—In impeller pumps, of which the centrifugal is a familiar example, the volume of water is moved by the continuous application of power through some mechanical agency or medium. The centrifugal pump consists of a set of straight or bent vanes or impellers mounted on a shaft, the whole rotating in a specially designed case. The water which enters between the vanes, through an annular orifice surrounding the shaft, is thrown outward toward the periphery by the centrifugal force developed by the rotation of the shaft.

As the apparatus contains no valves or parts, it is particularly adapted to the handling of water containing sand or grit. As its discharge is continuous, it has an advantage over reciprocating pumps in freedom from water hammer in the suction and discharge pipes.

Each centrifugal pump is designed for special conditions of head and speed and operates at maximum efficiency only when these conditions are fulfilled. When any alteration occurs in these two factors, a corresponding drop in efficiency is noted.

The ordinary efficiency of a centrifugal pump varies between a minimum of 50 per cent. and a maximum of 80 per cent.

Deep Well Pumps.—There are three principal types of deep well pumps adapted to small water works installation, namely: the reciprocating, centrifugal and air lift. The first two are similar in principle to the respective types discussed above and need no further discussion.

The air lift involves the discharge at the bottom of the well, or at least a considerable distance below the water surface, of air into the mouth of the delivery tube. The air mixes with the water and the specific gravity of the mixture is so reduced that the pressure of water outside the delivery tube causes the mixture to overflow at the top. Evidently, the greater the length of pipe below the surface, the greater the difference between the weight of the columns within and without the tube, *i.e.*, the greater the submergence and the higher the water can be lifted. Generally the depth of submergence is made 1.5 to 2 times the lift.

The air lift is especially adapted to raising water from great depths. The efficiency varies between a minimum of 15 per cent. and a maximum of 45 to 50 per cent.

PIPING SYSTEM

General.—The piping system includes all mains and lateral pipes, standpipes and distributing reservoirs, gates, meters, and all services and connections. The piping in a distribution system must be designed so that water can be supplied to any point at any time at the greatest rate that may fairly be demanded at that place.

Reservoirs.—The purposes and functions of a service reservoir are:

1. To equalize pressures in the distribution system, by providing a nearly constant level water surface from which these take their source.

2. To equalize, or to reduce to a uniform rate, the draft upon the transmission lines leading from the source of supply and in this way to increase their adequacy and thus postpone the necessary increases in the capacity of such lines.

3. To provide a reserve supply of water to be used in such emergencies as conflagrations, or failure of the transmission lines by rupture, or to tide over supply troubles of short duration.

4. To equalize the momentary variations between supply and demand and fluctuations in pressure.

5. To allow more uniform operation of pumping machinery.

The proper size of reservoir to meet the above conditions is determined by the fluctuations in domestic draft and fire fighting uses. In general, in small communities, especially where water is supplied from a distance, the service reservoir should hold at least one day's supply. For fire protection, the National Board of Fire Underwriters recommends a capacity sufficient to maintain the total number of required fire streams for a period of from 6 to 10 hours.

There are three general types of service reservoir, namely;—basins, usually constructed in cut and fill and generally lined with masonry; standpipes of concrete or steel; and tanks of wood or steel.

Basins are usually constructed on the top or side of a hill of sufficient elevation to give the requisite pressure. The most economical shape is determined by its location, the round reservoir often being used on a hilltop, while an oval shape is better suited to side hill locations. It is not unusual to cover the reservoir with a concrete roof of the groined arch type.

Standpipes are well suited to the use of small communities, especially where the consideration of pressure is vital. The general practice has been to install standpipes and elevated tanks of sufficient capacity to properly protect the small community. A capacity of 30,000 gal. is a minimum even for the smallest community. Reinforced concrete has been used successfully for tanks of a variety of diameters and heights, as large as 100 ft. and 150 ft., respectively. Some difficulty has been experienced in obtaining waterproof joints in the concrete, especially in the higher standpipes.

Steel standpipes were much used until about 1910, but owing to their greater cost and the great danger of failure of high standpipes, few are being built now. Elevated wood and steel tanks are largely replacing standpipes in small communities.

Fire Service.—*Quantity Required.*—The amount of water to be provided for fire service depends upon many circumstances; among others, the size and proximity of buildings, the materials and methods of construction, the available pressure, the availability of auxiliary fire systems, the probable loss of life and property from a bad fire, the cost of making a given quantity of water available and the financial ability of the system or community to pay for doing it.

Authorities differ somewhat in the number of fire streams

required simultaneously to quench fires in various sizes of American cities, as shown below in Table 26.

TABLE 26.—ESTIMATED NUMBER OF FIRE STREAMS REQUIRED SIMULTANEOUSLY IN AMERICAN CITIES OF VARIOUS MAGNITUDES[1]

Population of community	Number of fire streams required simultaneously			
	Freeman	Fanning	Shedd	Kuichling
1,000	2 to 3	..	..	3
4,000	......	7	..	6
5,000	4 to 8	..	5	6
10,000	6 to 12	10	7	9
20,000	8 to 15	..	10	12
40,000	12 to 18	..	14	18

[1] Turneaure & Russell: Public Water Supplies, 1916, p. 745.

The values as given by Mr. Kuichling, which have been widely used, may be expressed by the formula $y = 2.8\sqrt{x}$, where "y" equals the number of streams and "x" equals the population in thousands.

Another method of computation used by the United States Shipping Board, Emergency Fleet Corporation, Passenger Transportation and Housing Division, in its recent housing developments, was to provide, in addition to the domestic supply, fire protection capacity at a rate computed in million gallons per day equivalent to the square root of the population in thousands.

During fires, however, it should be possible to maintain the draft on the distribution system without seriously interrupting the domestic or industrial service. In other words, the system must be adequate to care for a conflagration, plus normal industrial and domestic demand, and this mark must be set as the goal in the design of a proper distribution system.

Pressure Required.—For fighting fires directly from the mains, without the use of auxiliary fire engines, the National Board of Fire Underwriters requires not less than 90 lb. per sq. in. at the curb, where the length of hose is not to be more than 300 ft. Greater pressures are required for longer lengths of hose. However, medium pressures of 45 to 70 lb. per sq. in. are permissible and quite useful for moderate streams with short hose lengths; for inside work in buildings of three or four stories; also for sprinkler systems in buildings of small to medium height.

Fire service pressures of 100 lb. per sq. in. and over cause leaks in plumbing and increased waste; water pumped at high pressures contains air bubbles as drawn from the faucet, making water uninviting for drinking. Few cities in the United States carrying fire and domestic supply in the same pipes have hydrant pressure of 100 lb.

Standard Fire Streams.—A stream flowing 250 gal. per minute, through a smooth nozzle 1⅛ in. in diameter, with a pressure at the base of the tip of 45 lb. per sq. in., constitutes a standard fire stream. Such a stream is effective to a height of 70 ft. above the ground with a horizontal carry not exceeding 63 ft. When fed through the best quality of 2½ in. rubber-lined hose, the hydrant pressure required to throw such a stream, taken while the stream is running, is as follows:

Feet of Hose	50	100	200	400	600
Pounds per sq. in.	56	63	77	106	135

Hydrants.—Hydrants are attached to pipes in the distribution system to allow water to be drawn for fire purposes. They are of two general types; the post hydrant, in which the barrel of the hydrant extends 2 or 3 ft. above the ground surface; and the flush hydrant, in which the barrel and nozzle are covered by a cast iron box, flush with the surface. The former is more commonly used and as it is much more readily found and more conveniently operated, it is to be preferred.

The branch supplying the hydrant should be of a size corresponding to the number of streams to be carried. For one fire stream, the branch may be 4-in., for two streams, 6-in., etc. In general, valves should be placed on all hydrant branches where the main is 10 in. in diameter or larger. The barrel or standpipe of the hydrant should have an area about 20 to 40 per cent. greater than the area of all its nozzles.

The committee of the American Water Works Association recommends that in thickly built-up mercantile and manufacturing sections, hydrants should be spaced about 200 ft. apart and not more than 500 to 600 ft. apart as the maximum anywhere.

In fixing the exact location of the hydrant and the side of the street on which each should be placed, a detailed examination should be made and the location determined with reference to important buildings and convenience of access in case of conflagration. The most convenient location for hydrants is generally

at the street intersections, as they are then readily accessible from four directions. General practice appears to be to place the hydrant 5 to 10 ft. inside the range of the property line about 1 ft. back of the curb, as shown in Fig. 27 herewith.

Design of Pipe System.—*Minimum Sizes.*—The National Board of Fire Underwriters specifies that six-inch pipe is to be considered the minimum size satisfactory for hydrant supply in residential districts, to be closely gridironed with 6-in. cross-connecting mains at intervals of not exceeding 600 ft.; but where initial pressures are high, a satisfactory gridiron system may be obtained by a liberal per cent. of larger mains cross-connecting the 6-in. at greater intervals. In new construction, 8-in. should

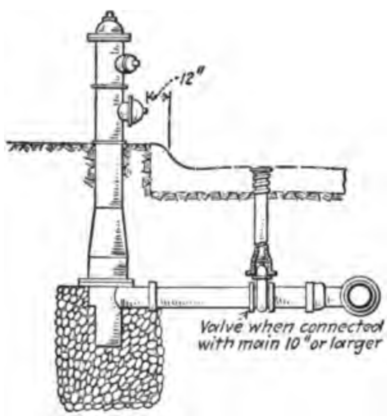

Fig. 27.—Standard fire hydrant connection.

be used, where dead ends and poor gridironing are likely to exist for some time. In high value districts, the minimum size should be 8-in., with suitable cross-connecting mains; 12-in. and larger mains to be used on the principal streets and for all long lines not cross-connected at frequent intervals.

In general, in small housing developments, 4-in. cast iron pipe may be used for short lengths not requiring hydrants directly attached, and especially where well connected into the rest of the system at both ends. Galvanized iron pipe, of 2-in. and upward to 3½-in., may be used occasionally in streets for house supply only, where hydrant service is not imperative, where population is sparse, or where the cost must be kept to a minimum. A typical piping system is shown in Fig. 28.

Fig. 28.—Plan of water distribution system installed in the Loveland Farms housing development.

General Design.—While no absolute rule will apply in all cases for the design of the distribution system pipe sizes, the following data used by the Division of Passenger Transportation and Housing, United States Shipping Board, as a guide to pipe sizes may be helpful.

TABLE 27.—POPULATION THAT CAN BE SUPPLIED BY PIPES OF VARIOUS SIZES—BASED ON AN AVERAGE USE OF 100 GALLONS PER CAPITA DAILY, WITH AVERAGE AMOUNT OF FIRE PROTECTION

Diameter in inches	Sectional area, sq. in.	Flat slopes long lines, $V = 2$ ft.-sec.	Average conditions, $V = 3$ ft.-sec.	Steep slopes short lines, $V = 4$ ft.-sec.
4	13	12	27	48
6	28	61	132	226
8	50	182	392	666
10	79	425	900	1,500
12	113	835	1,720	2,850
16	201	2,320	4,620	7,400
20	314	4,940	9,520	14,900
24	452	8,900	16,700	25,500

Length of Mains.—Little can be gained from a study of the length of mains per consumer, as much depends on the shape and size of the town. However, it will be of interest that in developments of the United States Housing Corporation the average length was 0.75 ft. per front foot of lot, or 1.50 ft. per linear foot of street.

Depth and Location.—The depths to which mains must be laid to prevent freezing is dependent upon several factors, namely, the temperature, the character of cover and the size of main and velocity of flow. The report of the Committee on Depth of Water Pipe of the New England Water Works Association[1] shows, as a result of a questionnaire sent to 90 communities supplied by water works, that, in general, pipes are laid from 3 to 10 ft. deep, according to the latitude, and that freezing occurs mainly on dead ends and at night when the velocity is low. All but three cases of freezing were reported on mains smaller than 10 in. in diameter, and in all cases the ground was frozen below the axis of the pipe. In general, freezing extends 1 ft. deeper in streets than in fields; also, in streets, frost will reach about 1½ ft. deeper in gravel than in clay.

[1] Jl. N.E.W.W. Assoc., Vol. 23–24, p. 435.

A summary of the results of the work of the committee is shown in Figs. 29 and 30, giving the relation between latitude and the mean temperature of the coldest month and the relation

Fig. 29.—Map indicating the mean temperature of the coldest month of an average year.

between the mean temperature and practice in laying mains. The median line represents general practice only, and as little

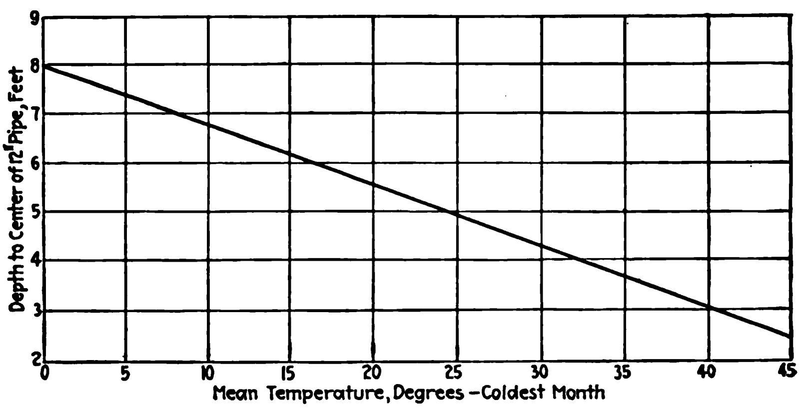

Fig. 30.—Relation between required depth of water pipes and mean temperature of coldest month in average year.

or no trouble at these depths has been experienced from frost, it is probable that the data may be used as a safe guide.

Water pipes are usually located in the streets at a uniform

distance from the curb or property line, although in some cases considerable economy may be effected by running the pipe lines through easements in the rear of lots.

Valves.—Valves should be introduced in the system at frequent intervals, so that comparatively small sections can be shut off for purposes of repairs, connections, etc. As a general rule, whenever a small pipe branches from a large one, the former should be provided with a valve. At intersections of large pipes, a valve in each branch is usually desirable.

Valves should be located systematically. They are usually placed in range, either with the property line or the curb line, but sometimes they are placed in the cross walks.

The United States Shipping Board, in its housing developments, recommended a valve spacing such that only three blocks of pipe are thrown out of service at one time, in case of a break or need for repairs.

Specials.—The percentage of the total cost of a distribution system which may be chargeable to specials varies considerably in individual cases, but, in general, lies between 4 and 6 per cent. of the total cost. In supply lines the number of specials required, and hence the percentage of the total cost, is less, representing only from 1 to 2 per cent.

House Services.—The connection between the street main and the consumer's premises is made by means of a service pipe. Just within the cellar wall of the consumer's building a stop-and-waste cock is provided. Usually the municipality or water company installs a curb cock, protected by a suitable box under the sidewalk close to the curb.

The practice of tapping the mains to receive the corporation cock varies in different localities. The small mains are usually tapped on top, while the larger mains are tapped on the side.

TABLE 28.—COMMON PRACTICE IN TAPPING MAINS IN VARIOUS LOCALITIES

Place in tapping	Number in list	Per cent. of whole
Top of main	28	32.6
Side of main	39	45.3
45° point	12	14.0
Various parts	7	8.1
Total	86	100.0

Reports from 86 communities solicited by the New England Water Works Association[1] show the preceding practices.

Unless the service pipe is made of lead, a lead goose neck about 2 ft. long should be placed between the corporation cock and the

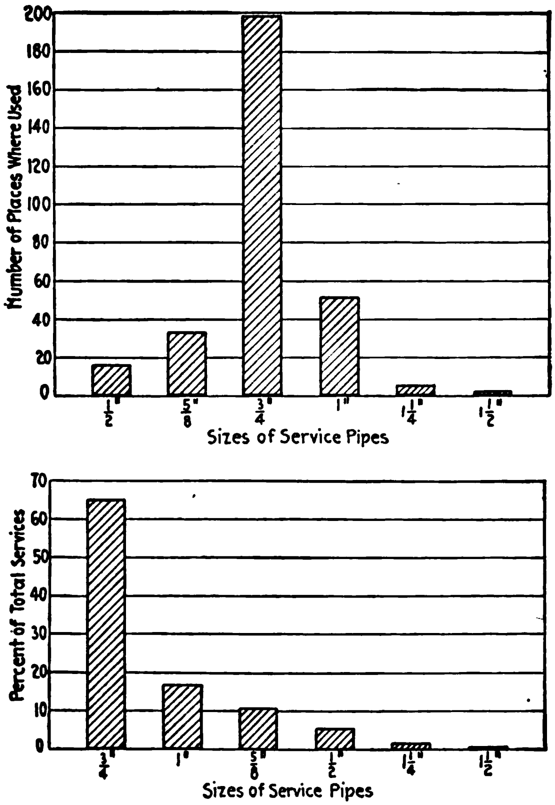

FIG. 31.—Size of water house services; the practice of cities and towns as to the size of service is shown diagrammatically in the upper illustration; the lower diagram indicates the extent of the use of the various sizes in terms of the total number of services. NOTE: Data based on records from 305 cities and towns.

service pipe to enable the latter to adapt itself to any settling that may occur.

In selecting the kind of service pipe to be used in any particular case, the points to be considered are: (1) the chemical action the water may have on the pipe; (2) the cost of laying and maintaining the pipe; (3) its durability.

There are few, if any, places where it is advisable to use un-

[1] Jl. N.E.W.W. Assoc., Vol. 23, p. 436.

coated iron or steel in service pipe construction. The use of galvanized pipe decreases very materially in most cases the troubles experienced from the use of plain wrought iron or steel.

Lead pipe is mechanically an almost ideal pipe for services on account of its pliability and the ease of laying in places where there are obstructions. The chief objection to lead is the chance of lead poisoning which in certain localities with certain kinds of water is extremely serious.

Cement lined pipes are the most satisfactory, so far as the action of the water is concerned, of any which are now used for services. The difficulties which arise from the use of this material are solely mechanical, although corrosion will take place on the outside of the pipe unless this be protected.

General practice appears to favor the installation of ¾-in. diameter services, as is shown by a study of records of 305 cities

TABLE 29.[1]—PORTION OF HOUSE SERVICES LAID AND PAID FOR BY THE WATER DEPARTMENT IN VARIOUS COMMUNITIES

Place or amount laid	Number of places			
	New England	Other states	Total	Per cent.
None	27	17	44	15.0
Curb or property line	94	24	118	40.2
To cellar wall	117	6	123	42.0
Corporation cock only	0	6	6	2.1
Miscellaneous	2	0	2	0.7
Total	240	53	293	100.0

Place or amount paid	Number of places			
	New England	Other states	Total	Per cent.
None	41	38	78	26.8
Curb or property line	174	10	184	62.4
Corporation cock only	8	4	12	4.0
Corporation and curb cock	3	0	3	1.0
Miscellaneous	15	2	17	5.8
Total	241	54	295	100.0

[1] Jl. N.E.W.W. Assoc. Vol. 31, p. 342.

and towns on Fig. 31 herewith. The portion of the house service which is laid and paid for by the water department in various communities is shown in Table 29 herewith.

Some economy is effected by laying the house service in the same trench as the sewer connection. The depth below the surface is usually the same as that of the street mains.

CONTRACT PLANS AND SPECIFICATIONS

Contract Plans.—The contract plans should consist of a general plan showing the location of the system in its entirety and a set of detail plans of a standard scale, each covering a portion of the total layout.

The general plan may or may not include the source of supply on the same sheet, but should give a comprehensive view of the whole distribution system. A scale of from 200 to 400 ft. per in. is well suited for this work.

The detail plans should be on a 40 or 50 ft. per in. scale, giving the approximate location and size of all mains and specials, together with a tabulation on each sheet of all specials to be used. The exact location of the mains may or may not be shown on the detail plans.

In addition, the contract plans should contain drawings of typical sections of house services and hydrants, showing the location of corporation cocks, curb boxes, valves, etc., in their relation to sidewalks, property lines and street mains.

Specifications.—*Pipe and Specials.*—Specifications for pipe and specials have been adopted by the New England Water Works Association and the American Water Works Association and foundries are prepared to furnish pipe as specified. These are complete and the result of careful thought and coördination of all interests. However, the specifications should include sections on Special Markings, Tests and Weighing, and such special requirements for the particular shop as appear necessary to prescribe.

Pipe Laying.—Sections covering the following items should be included in the specifications under this head: Care in Handling, Cleaning and Inspection, Laying, Cutting, Joints and Caulking, Joint Materials, Wall Pipes, Field Testing, Allowable Leakage, Painting and Correction of Defects.

Under this head may also be included the minimum cover over pipes.

Miscellaneous.—Under this head may be included specifications for Excavation and Backfilling, Hydrants, Valves, etc., Work to be Included, Measurement and Compensation; the latter should be carefully detailed and made explicit.

FINANCIAL

General Considerations.—The cost of supplying water to the consumer depends upon so many factors which in turn are so variable, that data on the total cost of supplying water would be of little value. It is the intention here to point out only the various items of revenue and expense which constitute the financial end of water works management, together with such information on the cost of the various factors as may be applicable to industrial housing developments. Such information, even though of very general application, will yet serve as a guide in estimating in a preliminary way the cost of a water supply.

Yearly Expenses.—The yearly charges and expenses to be met will include some or all of the following items:

1. Interest on bonded debt incurred for construction.
2. Yearly payment into a sinking fund for liquidating the bonded debt.
3. Yearly payment into a depreciation fund, to provide for the renewal of various parts of the work when worn out or otherwise rendered valueless.
4. Yearly operating and maintenance expenses.
5. Yearly cost of extensions and improvements.
6. Profit, or income for surplus.

Items (1),(2) and (4) must evidently be met year by year by the annual income and not by borrowing, if the department is to remain solvent. Some questions may arise as to what items are chargeable against maintenance, but in general it is better to include under that head only the regular up-keep and the cost of ordinary repairs.

To provide for both items (2) and (3) simultaneously is usually considered too liberal toward the future generations, but occasionally may be adopted in part. In municipal practice, the sinking fund usually receives the only consideration. If such is not provided, then a depreciation fund is necessary. This should be sufficient to furnish funds for the renewal or replacement of worn out and discarded parts.

The cost of extensions (5) may properly be met by issuing bonds or new securities, and at the same time providing a corresponding increase in the sinking or the depreciation fund. Such expenses are, however, frequently paid in part from the annual receipts or by general or special taxation in the case of municipal works.

Sources of Revenue.—The sources of revenue are the water rates and the funds received by general taxation, if any, for building portions of the system. The former are paid by consumers of water; the latter are paid by assessment on all taxable property. Ordinarily from 25 to 50 per cent. of the total fixed charge, (the part of the service chargeable for fire protection), plus the cost of water for public purposes, should be met by general taxation; and the remainder of the revenue obtained from the water rates.

The question of rate schedules is a subject demanding a separate treatise, and it is sufficient to say here only that such should be prepared by one thoroughly trained in the subject, and provide among other things:

First.—It shall produce the required gross income.

Second.—It shall distribute that gross income equitably among the various consumers.

Third.—It shall tend to develop the business and should not drive away large, long hour consumers.

Fourth.—It shall not sell water to any consumer at a cost so low that it is necessary to collect an unfair excess from other consumers, or so low that it is necessary to collect more from the other consumers than would be the cost if the large consumer in question were not served at all.

Fifth.—The schedule must be practical and workable.

CHAPTER VII

SEWERAGE AND DRAINAGE

General Considerations—Separate Sanitary Sewers—Storm Drainage Systems—Combined Sewers—Sewage Treatment and Disposal—Contract Plans and Specifications

GENERAL CONSIDERATIONS

Sewerage and drainage are not only important elements in first cost and upkeep but are closely related to the health and well being of the community. When such are not properly planned and constructed the health of the town, or that of adjoining communities, may be menaced; property may be subjected to damage, and excessive, and perhaps otherwise avoidable maintenance or upkeep costs incurred directly or indirectly. The day has gone by when the self-respecting worker will permit his family to live in a community with privy vaults and with poorly drained land and wet cellars.

Objects to be Attained.—The object sought, with respect to sewerage—is the prompt and effectual collection and disposal of domestic sewage and trade waste; with respect to drainage—is the collection and removal of rain water or surface drainage. There may also be the problem of enclosing small water courses, to an extent necessary to make possible the improvement of the property.

The first subject, sewerage, is essentially one of health and public convenience, and is of prime importance. The second, drainage, is related chiefly to the physical requirements of maintenance and upkeep of property, and is provided for the purpose of preventing erosion of lawns and pavements, flooding and drainage to public and private property and to conserve public convenience.

The following points must be kept ever in mind: first cost; maintenance and operation costs, both direct and indirect; health and sanitation; the requirements of public convenience and satisfactory and adequate service. These are of great im-

portance and failure to make proper provision may react to the detriment of the property, to the dissatisfaction of owners and tenants, and so limit or restrict the most profitable development of the town site. It may not be out of place here to point out the fact that the rule-of-thumb methods, generally prevailing a generation ago, the use of which has necessitated costly reconstruction and replacement of sewerage and drainage systems in many American communities, have given way to more exact and reliable methods of planning and design. With the prevailing high costs, and scarcity of labor and materials, the necessity for attention to economical considerations is more than ever urgently necessary.

While a number of years ago it was possible to construct a sewerage system which would render satisfactory and adequate service at a rental charge of not over $6.00 per annum per house (provided treatment costs were not excessive), it is doubtful at the present time if a satisfactory system can be installed to render service at a rental charge of less than $12.00 per year. Irrespective of whether or not this charge falls upon the owner, tenant or the municipality, it is, in the last analysis, an item of rental, and must be kept to the minimum consistent with proper standards of health and service.

The major problems to be considered are type and general arrangement of system, the method of disposal, and necessity for treatment, the capacity, general location and plan, and finally the detail design. At the outset, inquiry should be made as to the state and municipal requirements with regard to sewage treatment and disposal, and house plumbing, and a conclusion reached as to the nature and degree of treatment, if any, which may be required, and local conditions to be met.

Types of Systems.—Sewage and drainage may be effected by collection and removal in one system of conduits, in which case the system is called the combined system, or by the alternative plan, the separate system, wherein the domestic sewage is carried in a separate sanitary sewerage system, and the storm drainage in an additional and distinct system of storm drains.

The first question to be settled is that of type of system. Neither the combined nor the separate system have inherent advantages which render either preferable in all cases. The one to be selected is that which will render the required service at the least cost. As a condition precedent to making a decision on this

point, the method of sewage disposal, and the nature and degree of treatment required, if any, must be studied and solved in general terms, as it has a most important bearing on the selection and design of the type of system. The economical considerations concerned are susceptible of analytical study, dependent for their value upon the reliability of the underlying data.

As the rate of storm discharge, although intermittent, is much greater than the flow of sanitary or domestic sewage, the latter being ordinarily and approximately but one per cent. of the former, the separate system requires the laying of storm drains of approximately the same size as that required in the combined set. In addition, a system of small size sewers, is required, which ordinarily range from 8 to 12 inches in diameter, the greater part of the system being composed of 8-in. pipe. If the roof drainage is to be carried directly to the storm sewer, two sets of house connections are necessary for the separate system, one to carry the domestic sewage and the other the roof water. It therefore follows that, if all the streets are to be sewered and all houses connected both for domestic sewage and roof water, under most conditions the cost of the separate system would exceed that of the combined system. There are, however, other practical and economical considerations which may make it possible, in some cases, to install the separate systems at less cost than the combined. These are chiefly due to the comparatively lesser depth at which the storm drains may be laid, if separate, as compared to those required for the larger sized combined pipes when placed low enough to receive house wastes.

Many of the older communities are now sewered on the combined plan, by reason of the fact that until comparatively recent years the necessity of separate sewers, due to treatment required, had not arisen, and further, little attention had been given to the economical advantages to be secured in many cases by the adoption of the separate system. Where sewage and drainage may be effected by the extension of, or by connection with an existing system of combined sewers, it will generally be found advisable to install the combined system, unless the development of state or local sanitary policies may alter the conditions and requirements. It may, however, for economical reasons be found desirable to install the separate system in developing new areas, and make connection with the existing combined system, for the purpose of securing an outlet.

If sewage treatment works, or long and expensive outfall construction is found necessary, either the separate system is generally most economical, or the quantity of flow to be handled must be reduced by diversion of the surplus discharge during heavy rain by means of overflows into nearby water courses. If this latter procedure is permissible, the combined system, other conditions being favorable, may be installed; otherwise the separate system is clearly indicated. Where overflows are permissible, collection may be made in the combined system and the excess storm flow discharged at one or more points before the outfall or the treatment works are reached. Or, an alternative plan may be followed, wherein the dry weather flow, composed almost entirely of house sewage, is diverted into so-called interceptors. In some cases, and to an extent determined generally by the sanitary regulation of the state, two or three times the dry weather flow may be carried in the interceptor, in order to take care of the first wash of the streets. This will result in the development of an intercepting system which, however, is more often resorted to where sewer extensions and disposal of the sewage of a town already sewered on the combined system, is under contemplation.

Having determined the sewage disposal problem and where the selection of the type of sewerage system is not dictated or controlled by the local sanitary or health requirements, the conclusion will rest upon the relative estimates of the first costs of construction, and of maintenance and upkeep, with respect to the following factors; the depth of trench, and the character and quantity of excavation; length and size of the various sewers and drains; extent to which storm drains must be installed if the separate system is used; number and length of house connections. Topography and conditions of soil play an important part in these studies and estimates.

An economic advantage in favor of the separate system will result if the extent of the storm drainage system can be materially reduced. The conditions permitting and the manner in which this may be done, are later considered in the section bearing upon the design of storm drainage systems. The storm drains of a separate system may be designed for a somewhat less capacity than required at corresponding places in the combined system. This is being made possible by the elimination of the danger of backing up through house connections during excessive rains, and the unsanitary effects of flooding. Where the area to be

sewered is low-lying and flat, better results can generally be obtained by installing separate sanitary sewers. Self-cleansing velocities generally can be obtained at less cost, and with less pumping, on account of the better flow conditions which may be obtained with the smaller or flatter gradients; hence excessive maintenance cost and the nuisance of clogged sewers is avoided.

SEPARATE SANITARY SEWERS

The quantity of sewage to be provided for in the sewerage system and treatment works must be ascertained in order to fix their capacity. This involves a determination of the average daily maximum and minimum rates of discharge. The sources from which the flow is contributed are:—House or domestic sewage, emanating from the water closets, wash-stands and cellar sumps, carrying the discharge from dwellings and places of business; trade wastes, which include waste products and waste water used in processes of manufacture; leakage or infiltration into the sewers. With respect to the different districts contributing sewage the areas may be classified as residential, commercial, and manufacturing or industrial; each with its peculiar features and characteristics as to quantity and quality of sewage, and fluctuation in rate of discharge.

Quantity of Domestic Sewage.—The average daily quantity of domestic sewage contributed bears a close relationship to the use of water, is proportional to the population and is the product of the population and the per capita contribution.

Where an isolated development of known extent is under consideration, the number of dwellings being known, the population to be provided for may be ascertained by allowing an average of five persons per family, making suitable allowance for boarding houses, hotels and any public use of water. More thorough studies will be required, where an existing population is to be taken care of, or where there are undeveloped adjoining areas for which provision is to be made for future development. Under such circumstances the probable future growth of the community, as affected by local conditions and the expected growth of industry, and other factors, must be considered.

While it is desirable to ascertain the probable future population, it is not necessarily desirable and economical to make too great a provision for unknown conditions of the future which

may, or may not, eventuate. It may be more economical to provide additional and duplicate construction when the necessity arises. Street sewers, or laterals, and the smaller mains for built-up territory should be designed for ultimate conditions, regardless of the extent of the immediate building program. In the absence of more specific data an allowance of at least 45 persons per acre should be made for residential districts.

The average daily use of water not only varies largely in different cities but also in different parts of the same city or community. It is determined and affected by local customs and habits, and varies with the type or character of the district, reflecting in this manner the standard of living of the residents, and restrictions in the use of water. There is also a tendency for the use of water to increase with the age of the city. As the sewers must be designed to carry the maximum average daily flow at its maximum rate, we are concerned with this maximum rather than the yearly average, daily flow.

The average daily water supply in residential districts will range from 25 to 160 gallons per capita per day, with a general average of 100 gallons. In deducing the average daily sewage flow from water supply data an allowance must be made for losses and uses not reaching the sewers; and additions made for contributions from plants having private sources of water supply, and for leakage into the system.

Flow from Commercial and Industrial Districts.—The quantity of sewage to be contributed by stores and factories must receive special attention. The flow from small business or industrial sections can be assumed to be absorbed in the general average, insofar as the capacity of the mains are concerned; but care should be exercised that the lateral, or street sewers, into which such contributions are directly discharged, are of ample size to carry off the discharges at their maximum rates and deliver the same to the main sewer. The discharge from local groups of store buildings incident to the planning of any industrial town will therefore not introduce any important problems, except as to the required depth to remove sewage from deep basements.

When the commercial district is extensive, special study must be made of the probable requirements. The estimated flow to be provided for may then be based upon the number of employees, not resident in the district, using water at an assumed average rate. This may vary from 10 to 25 gallons per capita, with

suitable allowance for fluctuation so as to obtain the maximum rate, to which must be added the flow contributed by the residents.

The discharge of domestic sewage and trade waste from industrial and manufacturing plants varies through such a wide range, depending upon the size of the plant and the nature of the industry, and also upon the extent of sanitary facilities provided, that a conclusion as to the quantity can be reached only after a study of the particular existing conditions. The flow of domestic sewage can be estimated in the same manner as indicated for industrial districts; namely, upon the number of the employees and the average daily use of water, with special consideration as to the maximum rate of discharge. The latter is influenced greatly by the toilet provisions and the general habits of the employees.

Water is extensively used in many of the various processes of manufacture, and is ordinarily referred to as trade wastes. If included in the sewage discharge this will require special study as to quantity and rate of discharge. It is some times considerable and an estimate can be made only after a full investigation as to the particular processes and uses of water.

Leakage or Infiltration.—Provision should be made, in fixing the capacity of the sewers, to cover leakage, or infiltration, of ground and surface water into the system. Such leakage is due to ingress of water through the pipe joints, defects in house connections, defective construction of manholes and other appurtenances. It may be aggravated and become progressive by lack of proper maintenance, and by improper construction which causes subsequent settlement.

The quantity of leakage depends on the height of ground water, the nature of the soil, the features of design, particularly the materials and methods used in making the joints, and the care with which the construction is carried out. Defective house connections as installed, and later extended, replaced or repaired, are frequent sources of high rates of ground water leakage. In any event, there will be a normal amount of leakage which it is not practicable to prevent, and it is wise to provide a sufficient factor of safety to cover lapses in construction beyond the control of the designer.

As leakage is a factor primarily of the length and size of the pipes, and of the number of house connections; assuming good design and construction, the rational method of estimating its quantity is to estimate the same on the basis of the leakage per

inch of diameter per mile of system. The allowances made, to be on the side of safety, should be liberal. The following are recommended:

Under favorable soil and ground water conditions, 25,000 gal. per mi. of sewer for pipe not over 12 in. in diameter; and 30,000 to 50,000 gal. per mi. in excess of 12 in. in diameter. Under unfavorable soil and ground water conditions, an allowance from 50,000 to 100,000 gal. per mi. should be made. The latter figure will be used where ground water, in quantity, has a tendency to follow the line of the trench; also in low-lying, flat areas where the ground water level is above the top of the sewer. The above figures may be reduced 50 per cent. by use of bituminous joints.

For simplicity of computation it is convenient to convert the leakage allowance in gallons per mile of sewer, to gallons per capita per day. This may be done by using the assumed or ascertained density of population per acre and the lineal feet of sewer per acre. This latter quantity in the absence of specific data, may be taken to range from 175 to 340 lin. ft. per acre, with an average of 200 lineal feet.

Design of System.—Designs, even of a preliminary character, should be based upon adequate data, and upon suitable maps and plans. Reliable topography is of importance, in order to fix the approximate location, grades, and elevation of the main lines. The type and principal features of the system should be determined and known before the final adoption of the street plan of the development as sewerage and drainage are factors to be considered in developing such a layout. It is extremely difficult to make any changes in street locations after early ideas become fixed; accordingly necessity for early consideration of sewerage is indicated.

General Considerations.—The general arrangement of the system is, therefore, necessarily fixed within the developed area by the adopted street location, which in turn is affected largely by topography. The sewers should be located as far as possible in public thoroughfares, or in easements, where the latter are used instead of alleys. Outside of the developed area, location will frequently be made on private rights of way, or easements. These should be selected with reference to economy of construction, minimization of property damage and future street locations. Definite agreement for these should be early

obtained, covering the width, location, and the rights of the parties interested.

One of the objects sought in design is the elimination of large size pipes or conduits, as far as possible. To some extent this means the utilization of the smaller sizes to the limit of their capacity. The arrangement, however, will be limited and affected by other controlling factors, as the depth of cut and available grade. Where alternative location of large sewers is possible, determination of the character of the excavation is frequently desirable, in order to avoid difficult work in soft ground, or in rock.

Where there is a possibility of extending an existing sewerage system it should be thoroughly examined as to location of mains, grade, capacity and condition. In case of such extensions or where the housing site is within municipal limits, the local practice of the city should be followed, insofar as good practice and the requirements of the situation will permit.

Rate of Flow to Provide.—The quantity to be provided for is the maximum rate at which the flow will be discharged through the system at any time. It consists of the aggregate of the flows from the various sources previously discussed. The actual rate of flow varies from day to day and from hour to hour, and is also subject to seasonal changes and to progressive increase or decrease. The values for maximum rates used by various engineers vary widely; it is a matter of the application of general principles to the individual case. Care must therefore be used, in applying any recommendation, to suit local circumstances and requirements.

Laterals and street sewers, up to 15 in. in diameter, should be designed for a total capacity, running full, of between 375 and 550 gal. per capita daily; good average practice for residential sections, indicates about 500 gal. per capita. In ordinary municipal practice somewhat higher values are used. Sewers in excess of 15 in. in diameter may be designed for somewhat less capacity, which can be reduced for the reason that the fluctuation of flow decreases with the increase in number of persons contributing. An allowance of from 250 to 350 gal. per capita in the design of main and outfalls is good practice; 300 gal. per capita is the general practice in the design of many large and important interceptors and long sanitary outfalls.

An analysis of the ordinary maximum rate for a lateral system should be made along the lines indicated in Table 30.

TABLE 30.—ESTIMATED SEWAGE FLOW

From various source	Gallons per capita daily
Average daily flow, based on the average daily use of water...	100.0
Leakage or infiltration, estimated...........................	50.0
Manufacturing purposes....................................	10.0
Commercial purposes..	5.0
Total sewage daily flow	165.0
Add 50 per cent. for fluctuation, to obtain maximum rate....	82.5
Total maximum rate..	247.5

In computing the total capacity of the sewer along the foregoing lines, further allowance must be made for excessive fluctuations and contingencies, both present and future. To make such provisions, sewers of from 8 in. to 15 in. in diameter should be proportioned to run one-half, and the larger sizes should be designed to run two-thirds full. When the design of long interceptors or large mains is under consideration, special study should be given to the question of fluctuation and maximum rate. It should be borne in mind that, in designing sewers for a housing development, a somewhat less factor of safety may be used than in ordinary municipal practice, for the reason that some of the factors which are ordinarily a matter of estimate can be definitely ascertained in the former case.

The United States Housing Corporation issued the following instructions and suggestions: design to be based upon two families every 20 ft. of street, five persons per family; average daily use of water 125 gal. per capita; an allowance of 50 per cent. for daily fluctuation in flow; ground water leakage 25 per cent. to 75 per cent. of the average daily flow. This gives totals from 218.75 to 281.25 gal. per capita daily as maximum safe working units. This was stated to be applicable to small districts of 40 acres, or under, in area. Further suggestion is made that sewers, of from 8 to 15 in. in diameter, should be proportioned to run one-half full; so that the total maximum rate provided for is raised from 437.5 to 562.5 gal. per capita per day.

The United States Shipping Board, Emergency Fleet Corporation, Division of Passenger Transportation and Housing, in its instructions and recommendations for the design of sewers and drainage systems, recommended somewhat lower values. The

average daily flow, except in special conditions was assumed at 75 gal. per capita. The following rates were suggested as the basis of design for the sizes indicated.

For 8-inch sewer,	400 gallons per capita.
For 10 and 12-inch sewers,	350 gallons per capita.
For larger sizes,	300 gallons per capita.
All sewers flowing full.	

Additional allowance for ground water, from 25,000 gal. per mi. per day for 8 and 10-in. sewers, and 30,000 to 50,000 gal. per mi. per day for the larger sizes, was further recommended and was to be added to the foregoing where cement joints were used. With bituminous joints, leakage was taken as one-half of the foregoing.

Details of Computation.—The well known Kutter or the Williams-Hazen formulæ may be used for computations. The value of the coefficient "n," should be taken as 0.013 for pipe sewers and 0.015 for brick or masonry sewers; and "C" should be taken as 100 for terra cotta pipe sewers and 110 for brick or masonry sewers. Suitable hydraulic tables and diagrams are available, giving on inspection the velocity and discharge corresponding to the various slopes and sizes.

The data and results of the design should be arranged in tabular form, giving the location (usually taken at a point where additional flow is received from a connection, at an assumed point of concentration, or a change in slope) of the station or reference point; the elevation of flow line; quantity to provide for; grade; size; velocity and capacity.

Profiles of the lines should be prepared, showing the elevation of present surface, both on the center line of the proposed sewer and on the side lines of the street if the location be in a street. Where the depths of cellars of existing or proposed houses are likely to control the location of the sewers, their elevation and location should also be shown. The finished, or established grade, of the street should likewise be shown as well as existing surface and subsurface structures, where clearances or obstructions are involved.

Starting at the upper end the sizes are determined progressively, investigation for change of size being made at all points where there is sufficient increase expected in the quantity of flow. Such points will occur where branch sewers connect and as the contributions from house connections accrue.

Velocities and Grades.—The grades of a given size sewer cannot be reduced below a certain minimum without a corresponding increase in the probability, or necessity, for frequent cleansing, together with liability of serious clogging. When grades are not sufficient, sewer maintenance in opening up clogged sewers and in flushing, either with automatic devices or street hose, will be incurred, thus throwing an additional or needless item of cost upon operation.

Where possible a self-cleansing velocity of not less than 3 ft. per second, with sewers running full, should be obtained and adhered to as a minimum. This will obviate the necessity of flushing or cleaning. When pumping or excessive cost can be avoided by so doing the minimum velocity may be reduced to 2½ ft. per second; or even to 2 ft. per second in certain extreme cases, which will probably require some provision for flushing. The relative economy and desirability of velocities of less than 2 ft. per second should be compared with those of pumping; the factors to be considered being the cost of pumping, comparative amounts and depths of trench excavation, which are reflected in cost of construction, and the cost of cleaning and flushing in operation.

While some existing systems with velocities of 1 ft. per second have worked out without any large amount of deposit, such practice should not be followed without thorough investigation and consideration. In such cases flushing the dead ends and at points along the line of the sewer will be required.

An analytical consideration of the actual minimum velocity and of the shape of the sewer section is involved in consideration of the minimum flow in larger sewers and outfalls. The minimum flow may be taken as a proportion of the average daily sewage flow, or may be determined by analysis. It is composed of leakage or infiltration, which is fairly uniform throughout the day; the legitimate night use of water, ranging from 7½ to 15 gal. per capita, depending upon the habits of the residents; and the night use of water in manufacturing plants. It further includes the waste of water through defective fixtures, and such flow as arises from the habit of leaving fixtures open in freezing weather. The minimum flow, usually occurring at night, ranges as a rule, from 25 to 50 gal. per capita per day. Satisfactory flow conditions must obtain for carrying off the minimum flow. The velocity half full is equivalent to that when flowing full and as

the depth of flow decreases below one-half full, the velocity likewise decreases.

While the conclusions reached as to minimum discharge conditions in the smaller size sewers can be ordinarily relied upon, the design of the larger sanitary sewers, and of important outfalls and interceptors will necessitate more thorough study of the actual rate of minimum flow and the design of a special section, if sufficient velocity cannot be otherwise obtained. Such sections are so designed that the depth of flow and hence the velocity does not decrease as rapidly with a given quantity, as in the case of a circular sewer. Various shapes are used, of which the egg-shape, elliptical, and parabolic, with modifications, are common examples. Sewer sections of this kind are generally more expensive to build, require more head room and greater depth of trench and consequently take up more of the available fall than circular sewers; their offsetting disadvantages from this standpoint must therefore be considered. A maximum velocity of over 6 ft. per second is undesirable unless the normal flow is large, as otherwise there is a tendency for floating matters to be left behind.

For conveinent reference the following table giving minimum permissible grades for various size terra cotta pipe sewers, is offered; this being based on a value of 0.013 for the coefficient *n* of the Kutter formula.

TABLE 31.—MINIMUM PERMISSIBLE GRADES OF SEWERS

Diameter of sewer in inches	Slope in feet per 100 for velocity of 2 feet per second running full	Slope in feet per 100 for velocity of 3 feet per second running full
6	0.65	1.40
8	0.40	0.90
10	0.28	0.63
12	0.22	0.48
15	0.16	0.34
18	0.12	0.26
20	0.10	0.22
24	0.08	0.17
27	0.066	0.143
30	0.058	0.122

Changes in grade and in alignment should be made only at manholes, so as to facilitiate inspection and cleaning. Where

the street alignment is curved, the deflection should be made on chords, except when the diameter is 30 in. or more. This practice can be departed from only when the grades are such that self-cleansing velocities are absolutely assured. Changes in direction of the smaller sizes may easily be made by molding the curves in the base of the manhole, thus avoiding both the excavation of circular trench and making the deflection with pipe.

Computation should be made using the hydraulic grade line rather than the invert of the sewer as a basis. Also, to insure the realization of the capacity of the sewer and the fulfillment of hydraulic conditions, changes in size should be made by keeping the top of the sewer continuous rather than so maintaining the invert line.

Minimum Sizes.—The minimum size of the sewer should not be less than 8 inches. While the flow for considerable distance along the street can be carried in a much smaller sewer there is too much liability of clogging and stopping, nor is the slight saving in cost of a 6-in. sewer compared to that of an 8-in. sewer sufficient to warrant the adoption of the smaller size.

Depth and Location.—The depth at which sewers should be laid will be controlled first by the grade line, then by the amount required for protection, and finally by that elevation required to enable house connections to be made. The depth at which the house connection enters the street sewer will depend upon its length and the relative difference of elevation between that of the surface of the ground at the house and the finished grade of the street, and further, by the minimum depth at which the house connection leaves the house. Where no cellar fixtures are provided, or where cellars are entirely omitted, the depth of house connections will be fixed by the requirements for protection.

The required depth will vary with the latitude and climatic conditions, but it is good practice to allow a minimum of 2½ ft. of cover over the pipe. Frequently a cellar sump is provided and sometimes laundry tubs or other fixtures, in which case the main house drain is laid under the cellar floor. Cellar sumps are advantageous, in order to facilitate cleaning and to drain wet cellars generally where depth of the sewer system is a matter of economic concern, it is due to construction in low-lying, flat ground which at the same time is likely to cause wet cellars, either by leakage through cellar walls or by ingress of surface

water through openings. Such conditions are preventable, and the contingencies of construction should be anticipated even though additional, but not prohibitive cost, is incurred.

If it be desirable to raise the height of the sewerage system, or a part of it, in order to save pumping or construction costs, the main house drain can be suspended above the cellar floor; in which case cellar sumps or fixtures cannot be provided. The possibility of wet cellars must be forestalled by subdrainage of the foundation. The expense of this latter method must be compared then with the costs involved in lowering the sewer system. With a 6-ft. cellar, the floor of which is 4 feet below the adjoining surface of the ground, and a 20-ft. setback, a minimum depth of 7 ft. at invert of the street sewer will be required, in order to make a satisfactory house connection. The foregoing will be sufficient as a minimum for residential streets and where the nature of the ground occupancy is definitely ascertained. Where the character of abutting buildings is a matter of future determination, or where stores or other commercial buildings are planned or are likely to be built, the invert depth should be increased to at least 10 ft. and in some cases to 12 ft., so as not to restrict the use of the land for the most profitable purposes.

In fixing the depth and location of mains, attention must always be given to the question of future extension into adjacent tributary areas. Such growth may be rendered difficult and costly if the sewerage system, as planned, will not permit of extension. Participation of municipal authorities and of adjoining property owners may be often secured to cover the additional cost incurred.

In sidehill locations with houses on the higher side of the street it is possible to lay the sanitary sewers at comparatively shallow depths, while those on the lower side will require excessive depths. It thus may frequently be economical to sewer the houses on the lower side by laying a duplicate sewer in the rear of the houses in an easement or alley. Advantage may be taken also of the descending grade of a street, by laying the house connections at an angle of forty-five degrees and running down street.

Location may be either in the street, in which case the center line is desirable, as this permits the manhole covèrs to be laid level; or may be at the rear in an alley or easement. As it is desirable to remove as many of the substructures from the street

as possible, it generally follows that the sanitary sewer can be located in the rear of the house, not only with less disadvantage, but often with positive economy. The relative economy will be determined by the comparative length of house connections required for front or rear connection. There is a relationship here between the planning of the house and that of the sewerage system. With all fixtures in the rear of the house, unless the lots are too deep, there will generally be a shorter run to an alley or easement in the rear, than to a sewer in the center line of the street. This is further accentuated in cases where there is a large set-back. With the sanitary sewer located in the center line of a 50-ft. street, a 20-ft. set-back, the vertical soil pipe located in the rear or 28 ft. from the front of the house, and a lot depth of 100 ft.; the length of house connections will be 73 ft. when the sewer is located in the street as against about 55 ft. when located in a rear easement or alley. In this case there would be a further saving effected by reduction in the length of cast iron soil pipe within the building.

A further deviation from ordinary practice, to be considered where the street width warrants, consists in laying the street laterals in duplicate, one under each sidewalk, instead of a single sewer in the roadway. This removes the sewer from under the roadway pavement, always a desirable feature, and avoids opening up house connection trenches in the roadway; also shortens house connections, and permits a lessening of the depth of the street sewer, on account of the shortening of the house connections. The length of street sewer, however, will be doubled, but with street widths of 50 to 60 ft., the relative cost will be about equal and the question will be settled largely as a construction problem. With wider streets the comparative costs will be more pronounced in favor of the duplicate system. The arrangement of the sewerage system installed in Buckman Village, constructed by the Emergency Fleet Corporation, is illustrative of the latter kind of planning (Fig. 32).

Appurtenances.—Most of the accompanying details of a sanitary sewer system are subjects of such common practice that little more than mere mention need be made of them. It may be well, however, to state a few of the standard practices.

House Connections.—These may be laid with either 5-in. or 6-in. terra cotta pipe, the size depending upon the municipal plumbing requirements and local practice. The use of smaller

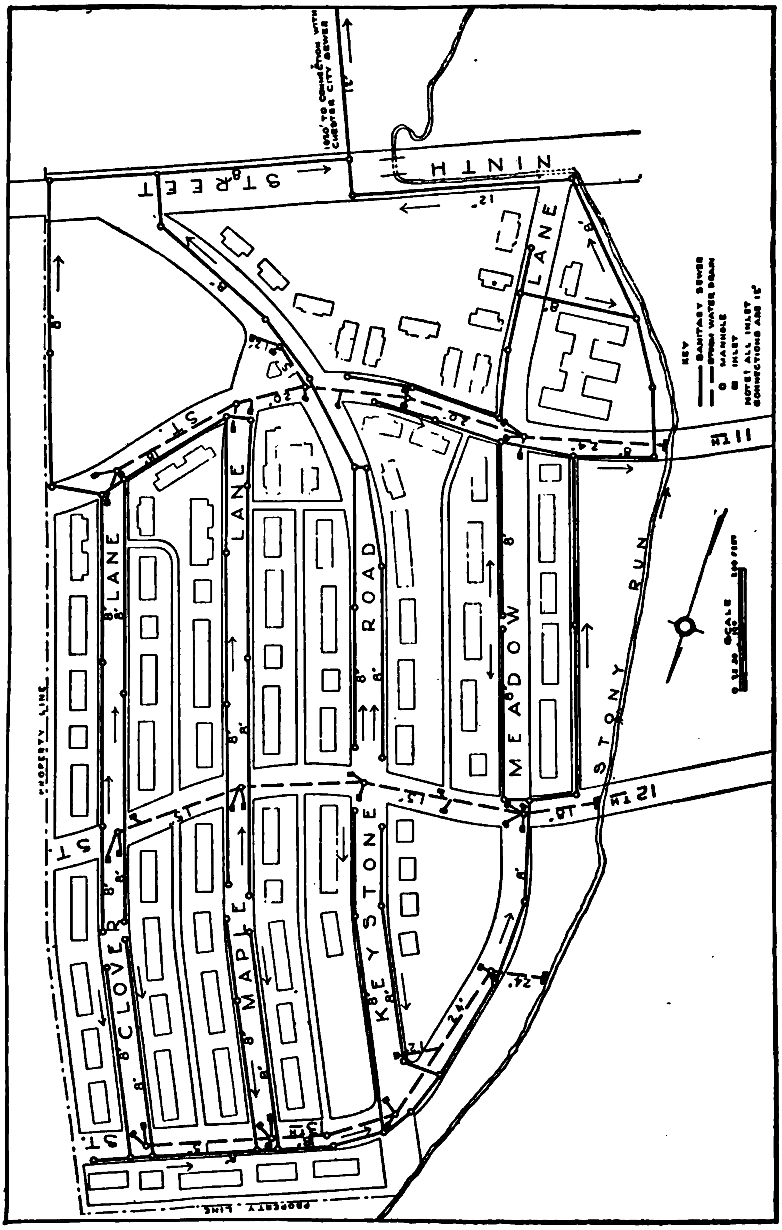

FIG. 32.—General plan of the sewerage and drainage system of Buckman Village, built by the Emergency Fleet Corporation; construction was facilitated by the duplicate system of sanitary sewers.

sizes is to be discouraged, on account of the likelihood of clogging.

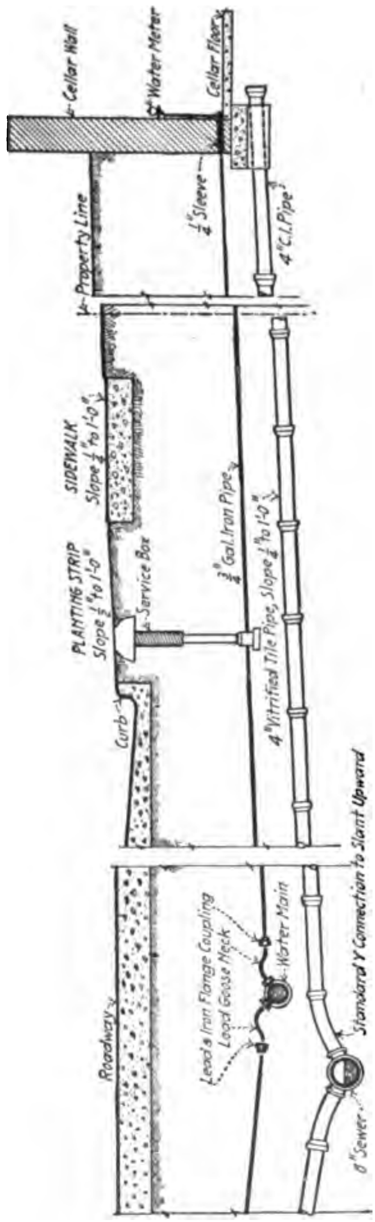

FIG. 33.—Recommended practice in location of the house water service and sewer connection.

Terra cotta pipe is generally laid from the sewer connection to within 5 ft. of the building, from which point cast iron pipe is used. Recommended practice in locating house connections is shown in Figs. 33 and 34.

House connections should be laid on a grade of not less than ¼ in. per ft., and it is not desirable to have the grade exceed ½ inch per foot. They should be laid in as direct line and grade as possible, and with the same care as that used in laying the street sewers.

The connection with the street sewer is made with a "Y", or Wye Branch, laid in the street sewer. Where there is separate ownership, or occupancy of a building, each dwelling should have its individual connection. Joint connections lead to litigation and irresponsibility for stoppages.

Manholes.—Manholes of ample size and proper design should be provided at intervals of from 250 to 350 ft., for sizes of sewer up to 30 in. in diameter; for the larger sizes a spacing from 300 to 500 ft. may be used, depending upon the size of the sewer. It is good practice to provide manholes at street intersections, at points of connection with other sewers, and at intervening points as required. In the smaller sizes of sewers

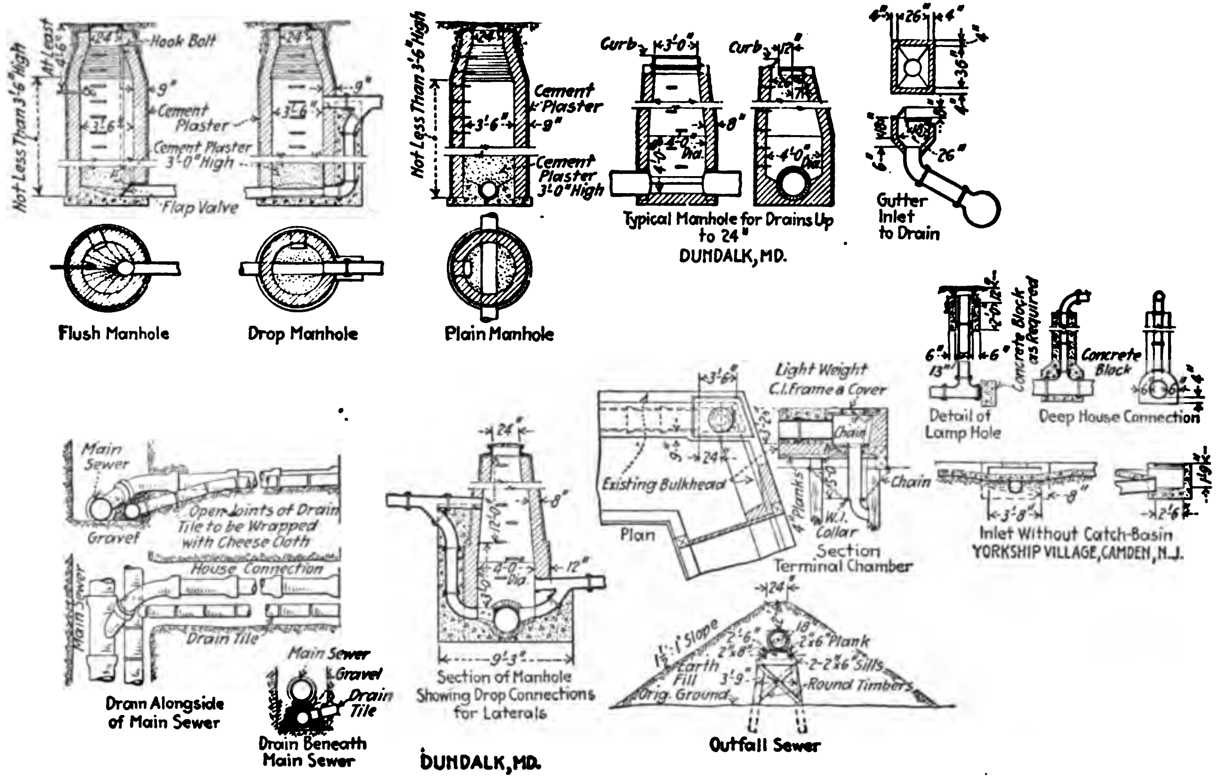

Fig. 34.—Standard designs and typical details for sewer construction developed by the Engineering Branch of the Division of Passenger Transportation and Housing of the Emergency Fleet Corporation.

and on flat grades it will generally be better practice to provide a manhole at both the P.C. and the P.T. of horizontal curves, but where the sewer is of sufficient size to be entered, one of the manholes may be omitted. The same practice may be followed where the grades are good and the liability of stoppage slight.

The manholes may be constructed of either brick or concrete, the latter being better in wet ground and all should be provided with manhole steps to permit of access. The sewers should enter and leave the manholes at or near the manhole invert. Manhole castings should be sufficiently heavy so as not to be dislodged and displaced by the movement of heavy traffic, and the manhole frames should be well bedded in cement mortar to prevent the ingress of water between the casting and the structure. Manholes with perforated covers should not be located in depressions or sumps and if so located care must be taken to provide a water-tight cover.

Joints and Fillers.—The cement joint is used for ordinary purposes. Where ground water conditions are bad, extra deep and wide sockets may be used with cement filler and hemp gasket; and when under considerable ground water head, bituminous joints are desirable to keep down the leakage.

Flush Tanks and Manholes.—When flushing is required by the design, either flush tanks, flush manholes, or facilities for flushing by hose should be provided. Flush tanks operating automatically discharge a limited quantity of water and are adapted especially to take care of dead ends, but are not effective where flat grades prevail throughout the system. In such case additional flush tanks of ample capacity or flushing manholes must be provided at considerable cost, or flushing must be done by other means. The two latter means require a maintenance force to operate.

Flushing manholes are of special construction, provided with a gate at each sewer opening into the manhole, which may be quickly removed. They are operated by closing the gate and partially filling the manhole; then a sudden release by opening the gate will discharge a large amount of water under head. Flushing by hose through a properly designed manhole is probably as economical as any method and likely to be quite as satisfactory. Typical sections of a number of the appurtenances and special features as designed by the Emergency Fleet Corporation, are shown on Fig. 34.

Inverted Siphons.—Inverted siphons are used to carry the sewer line under water courses, or other obstructions, which cannot be cleared without breaking the grade of the sewer. A velocity of not less than 3 ft. per second should be maintained in inverted siphons under all conditions of flow. Owing to fluctuations in rate this can be accomplished, only, by providing one or more additional lines of pipe of various sizes placed at different elevations. Maintenance of velocity in the small lines causes considerable loss of head and provision must be made for it. The head required for the smaller lines determines the total loss of head in the siphon. Clean-out gate chambers provided with proper stop plank, or gates, for manipulation of flow, must be provided at each end of the siphon. With proper care such siphons can be designed that will operate through many years without necessity of cleaning.

Foundations.—In firm ground, sewers can be laid directly on the excavated subgrade, the bottom of the trench being excavated to conform to the shape of the lower half of the pipe. In soft or yielding ground, timber platforms or cradles, or concrete foundations may be required to prevent settlement. In deep cuts, concrete reinforcement should be used, extending at least 6 in. under the pipe and being carried up well on the side. Railroad crossings should be made with cast iron pipe and also surrounded by concrete. In quicksand or other unstable soils, subject to considerable yielding, timber piles may be required in addition to timber or concrete cradles or platforms. Under many conditions in soft ground, it will be sufficient to lay a foundation consisting of a thickness of 6 in. or more of gravel or broken stone. A careful examination of soil conditions and bearing pressures will be profitable.

Pumping Stations.—Where pumpage is necessary it should be reduced to an absolute minimum by the elimination of all unnecessary flow, by making the system as water-tight as possible, and by arranging the system so that as much as possible of the flow can be carried off by gravity. This results in an arrangement called the zone system, in which sewage from the higher levels to the lowest limit which can be drained by gravity is collected and carried off in high-level sewers. Sewage from the lower levels is likewise collected in a distinct system and pumped either into a high-level sewer or carried by separate outfall to the place of disposal.

Unless there are exceptional conditions, or when a very large installation is under consideration, pumping is generally done by automatic machinery, using electrically operated pumps, controlled by units consisting of a float valve and rheostat.

The pumps should be of the open propeller type. In fixing the size of the pump to be installed the relative costs of pumping and investments in using mains of larger diameter should be considered. When large stations are under consideration, or where electrical current is not available, steam, gasoline, or oil driven units may be used. The essential features of such an installation include a receiving chamber, or well, permitting intermittent action of the pumps at an economical rate. Pump wells should provide for at least 15 minutes maximum flow. Bar screens, with coarse openings, arranged for easy cleaning, must further be provided in order to prevent clogging of the pumps. Units should be installed in duplicate and should receive daily inspection.

STORM DRAINAGE SYSTEMS

General Considerations.—The design of storm drainage systems involves considerations of general arrangement, capacity and extent of installation. The latter must be such as will preclude damage to property by erosion or flooding, prevent damage to pavements, permit the development of property, and add to and conserve public convenience to a reasonable and necessary extent. The extent of the installation, and likewise the cost, will therefore vary with the topographical and local requirements. The design involves consideration of the rainfall rate to be provided for, the maximum rate at which such rains will run off, the area covered by the system, and questions of location, depth and grade.

Rainfall and Run-off.—The quantity of rainfall is a most important factor. It is necessary to ascertain exact information as to the intensity and frequency of heavy downpours of rain, referred to as intense or excessive rains. For this purpose, the rainfall records of the nearest United States Weather Bureau office can be obtained, from which may be plotted the rate of each excessive storm, in terms of its rate in inches per hour for each 5 minutes of its duration. These curves show variations, clearly demonstrating that the arbitrary assumption of a certain rainfall rate is utterly unwarranted.

Rates to Provide For.—Rainfall diagrams will show a few abnormally excessive storms occurring at infrequent intervals. These are the rates determining the maximum which may occur over the period of years covered by the records, which generally extend back as far as 1871. As to whether or not provision should be made for the heaviest rainfall which may occur, will depend, entirely, upon the local conditions and circumstances.

Unless there are unusual topographical conditions occasional and limited surcharging of the storm sewers may not result

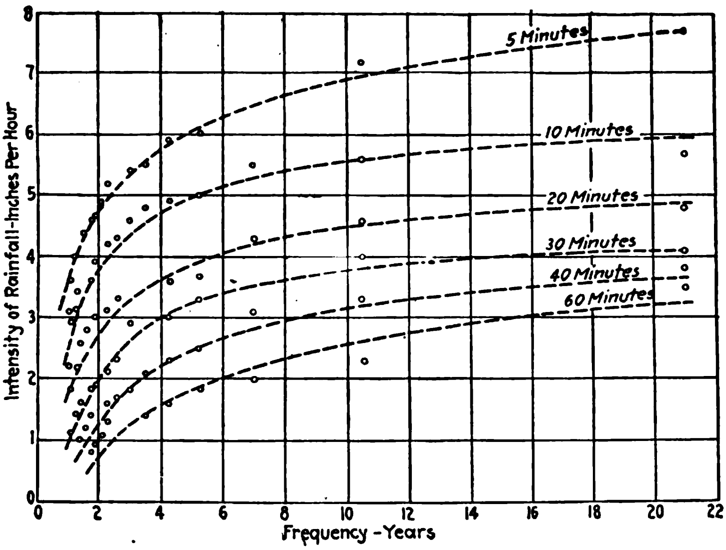

FIG. 35.—Rainfall frequency curve; shows the relation between the frequency and intensity of rainfall for storms of various durations for the Philadelphia district; one of a series of diagrams prepared by the Engineering Division of the United States Housing Corporation, Mr. John W. Alvord, Chief Engineer.

in great damage. This is particularly true where the overflow can be well distributed and at places where such surcharging will not flood cellars or seriously damage public or private property, nor unreasonably interfere with public transportation and convenience. Where street grades are good and the excess flow will be quickly carried off into water courses or ditches and where other favorable conditions exist, it will be good engineering practice and economy to design the storm drainage system without provision for the heaviest rains.

After careful consideration of the local conditions, it may be possible to reach a decision to anticipate such storms which only

occur at least once a year on the average, or the frequency provided for may be once in two years.

Fig. 35, reproduced from studies made by the United States Housing Corporation, will be of interest in this connection.

If property, likely to be damaged, is in business districts, it will be found desirable to make increased provision, so as to carry, without flooding, storms which may occur at intervals of five or even a greater number of years; or it may be necessary to even care for the maximum rate anticipated.

Run-off.—This is the amount of the rainfall reaching the drains, and is considered in terms of the maximum rate of discharge. Maximum run-off is expressed as a coefficient "C", in terms of the percentage of the rainfall rate; and is affected by the time of concentration, which is the interval of time that it takes from the beginning of the period of excessive rainfall to the moment when the maximum discharge is obtained in the drain. Time of concentration and the conditions affecting it are later discussed.

The coefficient of run-off "C", depends upon a number of conditions, among which are: the topography and prevailing slope, including the slope of the main drain; perviousness of the surface, which is dependent upon the character of the soil, proportion of lawns, sidewalks, street pavements, buildings; the condition of the surface of the ground prior to the beginning of excessive rainfall, as whether the ground is frozen, or saturated; and the duration of the storm.

An average coefficient of run-off may be assumed for the entire area and applied uniformly. When greater refinement is essential, the coefficient of the various tributary subareas may be ascertained by analysis. In general terms, and except in very flat or very rough topography, the value of the coefficient, for residential districts will range from 0.30 to 0.55 or 0.60. Under given topographical and soil conditions, the coefficient increases with the degree of development and the density of population, so that it is necessary to estimate the ultimate or future conditions which the system is to serve. Too much reliance cannot be placed upon the rate of discharge observable in open water courses; for, without other conditions being changed, the rate of discharge is increased by the installation of drains due to the fact that the time of concentration is shortened.

Under most conditions it is not safe to assume a run-off co-

efficient of less than 0.50, without careful analysis of local conditions. In sandy soils, where the topography is flat and the density of population not over 45 per acre the coefficient may be reduced to 0.30 or 0.35. In business districts the coefficient will be higher and will range from 0.80 to 0.90.

An analytical study of the coefficient of run-off is based on the imperviousness of the different kinds of surfaces. The coefficient likewise increases with the estimated duration of storms, as the impervious area increases owing to saturation. The following values may be used, on the basis of calling the coefficient 100 for areas immediately yielding all the water which falls thereon.

TABLE 32.—RUN-OFF FROM VARIOUS CLASSES OF SURFACES

Class of Surface	Per cent. Impervious
Roofs	90–100
Pavements—(a) Hard surface—sheet asphalt, grouted block stone, etc	80–90
(b) Macadam, gravel, hard earth, etc	30–50
Lawns, open spaces, etc	20–30
Sidewalks—paved surfaces	80–90
planting strips	40–50
Parks, cultivated areas, etc	5–25

The determination of the amount of each class of surface will give an average coefficient for the entire area considered.

The following is a table of values known as Frühling's coefficients arrived at in studies in Boston, Massachusetts.

TABLE 33.[1]—FRÜHLING'S VALUES OF RUN-OFF COEFFICIENT

Kind of Area	Value of "C"
Densely built center of city	0.7 to 0.9
Densely built residence districts	0.5 to 0.7
Residence districts, not densely built	0.25 to 0.5
Parks and open spaces	0.1 to 0.3
Lawns, gardens, meadows, cultivated areas, varying with slope and character of soil	0.05 to 0.25
For wooded areas	0.01 to 0.20

[1] From American Sewerage Practice: Metcalf and Eddy.

Extent of System.—Reference has already been made to the opportunity of lessening the cost by restricting the extent of the storm drainage system. It remains to point out under what conditions this can be safely done. There are two methods which can be used; first, where local conditions permit, the main or trunk sewers can be reduced in length, or perhaps entirely eliminated; second, the extent of the small street sewers or laterals can be minimized by eliminating the upper ends.

Nearby water courses, drainage ditches and drainage lines can be utilized as elements in the drainage system where the continuous use of such as open water courses is not objectionable. Sections of such natural water courses may be improved, where it is desirable, by realignment and rectification of grades and sections. Open water courses may be covered in congested districts and this is often necessary as a sanitary measure. When suitable precautions are taken there may be no reason why such water courses may not be used permanently, or for a considerable term of years, thereby deferring the first cost and saving the interest charge on construction. Where this can be accomplished the storm drainage system will naturally be reduced to its simplest units of street laterals of smaller sizes of pipe.

Roof Water.—The extent to which street laterals can be reduced or eliminated will depend greatly upon the provisions to be made for carrying roof drainage coming from the houses. When the buildings are well located, lot grading developed with care, and if subfoundation conditions do not indicate danger of wet cellars, the roof leaders may discharge on drip blocks and the flow carried over the lawn. In such cases it will naturally flow across the sidewalk and thence into the street gutters. If this is objectionable, a shallow tile drain may be laid, connecting with the roof leaders and extending across the lawn, through the sidewalk; thus discharge into the gutter through an opening in the curb.

Thus an elimination of the house and cellar drain may be worthy of consideration from an economical standpoint, although this practice is open to objection for certain reasons. In some municipalities the connection of roof leaders to the storm or combined sewers is required by ordinances or statute. There is also a prejudice against the practice of elimination as likely to cause wet cellars, and to make the sidewalk impassable in winter owing to freezing of such flow from the house. In this connec-

tion it must be borne in mind that roof leaders themselves frequently freeze and melting snow from roofs drips on the ground surface, and furthermore, there is always likelihood of a considerable proportion of the roof water during heavy rains not reaching the down spouts.

Numbers of wet cellars have been examined where the cause was ascribed to the discharge of the roof leaders to the ground directly adjoining the house, but in such cases the trouble generally has been found elsewhere, as for instance in lack of proper subdrainage of foundation where soil conditions were bad, or defective cellar wall construction. Whether it is advisable to effect the disposition of roof drainage in the manner indicated is largely a matter of judgment and preference, as to whether additional cost shall be incurred or the disadvantage permitted. The cost of connecting up the roof leaders to the storm sewer will run from $25 to $50 per house, depending upon the roof design and arrangement of yards.

Street Water.—The distance which water can be carried in gutters before reaching the first catch basin or storm inlet at the head of a street lateral depends upon the grade, the type of pavement, the gutter cross-section and the prevailing rate of excessive storms. Hard surface pavements, such as sheet asphalt or block stone are not subject to erosion, and under such conditions the gutter drainage can be safely carried a distance of about 1000 ft., if the grades permit, and provided the gutter capacity is sufficient. Pavements having less resisting qualities, such as water-bound macadam, are more subject to erosion, and in such cases a gutter run of 600 to 700 ft. generally should be the maximum limit. The spacing of inlets along the line of the drains is discussed later.

If storm water house connections are made, either the street laterals will have to be extended so as to take in the furthermost house on the street, or small drains may be laid under the curb. This latter practice should be considered where thorough subdrainage of the roadway pavement is essential. In such case small pipe, 4 or 6 in. in diameter, may be laid in broken stone.

The governmental agencies engaged in housing during the Great War endeavored to limit the extent of storm drainage systems to between one-third and one-half the length of the separate sanitary systems. Upon investigating the relative lengths of storm drainage and sanitary sewerage systems in a number of

these developments, it has been found that for the Emergency Fleet Corporation the length of storm drains is 46 per cent. of the length of sanitary system, while in the United States Housing Corporation the similar ratio is 55 per cent.

Details of Design.—The same general methods are employed in designing a storm drainage system as have been recommended in sanitary sewer design. The area to be drained is laid out in subdrainage areas, each served by a main lateral; and the area, coefficient of run-off, size, capacity, and grade of the main laterals draining each district determined. The size, capacity and grade of the main sewer is then determined starting at the upper end and proceeding progressively to the outlet.

The factors for design of the laterals, and mains, should be held consistently throughout the area, so that the various sections will carry off the same proportion of discharge. For instance, there obviously will be surcharging and flooding in the main if the laterals discharging into it are designed to carry off two inches of rainfall, whereas the mains are designed to carry but one inch.

Discharge Formula.—The use of empirical formulæ to determine the quantity of discharge and hence the capacity of storm drains is obsolete except for preliminary computation. In modern practice the so-called "Rational Formula" is used, which is as follows: $Q = ACI$. In this "Q" is the quantity of discharge in cu. ft. per second; "A" is the area tributary to the storm drain at the point under consideration and is expressed in acres; "C" is the coefficient of run-off, which has been previously discussed and which is expressed as a decimal; "I" is the rate of rainfall, corresponding to the time of concentration and is expressed in inches per hours.

The time of concentration, is made up of the initial period, or the time that it takes the water from the furthermost part of the area to reach the nearest catch basin or storm inlet, and the time of flow within the system. The initial period depends upon the slope, character of surfaces and the distance. For simplicity of computation it is ordinarily assumed from 5 to 7 minutes. After reaching the gutters, the storm water flows to the nearest inlet, and the time element here involved can be computed from the kind of surface and slope. After entering the lateral, the time of flow to the point under consideration can be easily computed, on the basis of the grade and size.

Should there be an outlying unsewered area, it will be neces-

sary to estimate the contribution from this source. This may be done by one of the empirical formulæ, such as the McMath or Burki-Ziegler. It is better practice, although taking more time, to develop the design to include this area, so that if later development occurs the system will be adequate to carry off the total discharge.

Velocities and Grades.—The minimum velocity in storm drains, flowing full or half full, should not be less than 3 ft. per second, otherwise deposits of grit, sand, gravel and other heavy materials may occur. If such a minimum velocity cannot be obtained without undue cost, it will be necessary to adopt precautions to prevent the admission of heavier materials into the system. This may be accomplished somewhat by providing properly designed catch basins.

High velocities are unobjectionable, provided the grades of the drain are sufficient to carry off heavy materials brought to it, but on sharp grades suitable precaution should be taken to prevent erosion or tearing out of the invert. The abrasive resistance of terra cotta pipe is sufficient to withstand conditions imposed by steep grades. Where large size sewers (in excess of 3 ft. in diameter) are to be constructed, it is usual to line the invert either with hard vitrified paving or sewer brick or with stone block—although monolithic concrete, if well constructed, has an equally high resistance to abrasion.

Computations of flow should be based upon the hydraulic grade or flow line, rather than on the invert line.

Minimum Size.—The minimum size of storm drains should be 10 in. in diameter, but where the installation is extensive, it may be desirable to increase the minimum size to 12 in. Some municipalities fix a diameter of 15 in. as the minimum size.

Depth and Location.—The crown of storm drains should be at least from 2 to $2\frac{1}{2}$ ft. below the finished surface; so as to afford protection. The drain, however, should be kept as close to the surface as possible, keeping in mind the requirements for house connections, junctions with other sewers, and clearance with other substructures.

Joints and Filler.—Cement filled joints are preferable, since tight construction is not necessary, and frequently not desirable where the storm drains may aid in subdrainage of the ground.

House Connections.—As there is little or no foreign material carried in the discharge from the roof leaders, house connections

may be laid on grades just sufficient to carry the estimated discharge. Six in. house connections are commonly used.

Manholes.—Manholes, which should be located at all changes of line and grade, should be spaced at intervals of from 250 to 400 ft. apart. Manhole covers should be perforated to permit of ventilation.

Catch Basins and Inlets.—When the velocity in the system is self-cleansing, full entrance storm inlets are preferable to catch basins. Traps on storm inlet connections are undesirable and objectionable and frequently fail of intended purpose. The inlet should be designed to give direct discharge into the connection, so as to prevent the retention or deposit of sand or other materials, and to provide ample waterway area. Inlet and catch basin connections, which should not be of less size than the minimum for street laterals, should be laid on a grade of not less than two per cent., and on as near a direct line as possible to the street lateral.

Catch basins are to be used only when it is necessary to prevent the discharge of heavy materials into the drains. Such design involves careful maintenance, the liability of stoppage and a possibility of nuisance. Where provided the catchment capacity should be ample to permit settling and retention of foreign materials, but even then the necessity of frequent cleaning is always present and excessive storms quickly fill such basins, thus rendering them of little effect.

Storm water inlets or catch basins should be provided at the following locations: at low points in the gutters; at breaks of grade in the gutters where the grade is perceptibly reduced; at points where there is a concentration of surface drainage from adjoining areas; at important street intersections. In business districts it will also be good practice to provide four rather than one or two storm inlets at intersections, so as to prevent flooding of the street crossing. Where the grade is continuous around the intersection, the inlet should be located at a point a short distance above the first sidewalk crossing. While it is more economical to locate the inlet at the midpoint of the curb arc or return, such location is unsightly and does not keep the street crossings clear from flooding.

At ordinary grades of from one to three per cent., inlets should be spaced at distances of about 500 to 600 ft. On flatter grades closer spacing will be desirable in order to prevent ponding or

pooling of water in the gutter, and on steeper grades such spacing also will be required to make it possible to catch the water moving at high velocity in the gutter at the inlet opening. The type of roadway pavement will have an influence on the spacing of inlets and where the surface is liable to erosion, deterioration, or disintegration by the action of water, closer spacing of inlets will be required, particularly on flat and steep grades

Typical drawings of storm inlets are shown in Figs. 34 and 36.

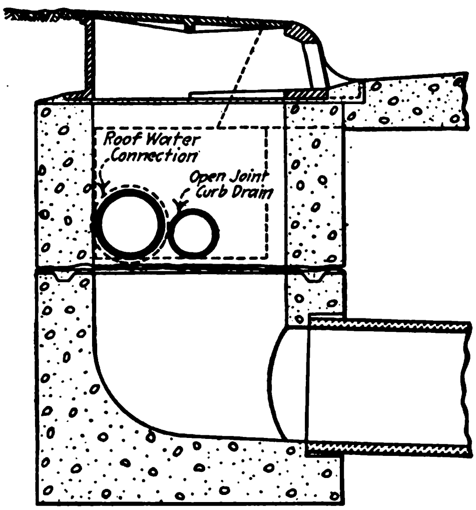

FIG. 36.—Typical storm inlet as designed for the Loveland Farms housing project.

Location.—When the separate sanitary sewer is laid in the center of the street, the storm drain is ordinarily laid between the curb and the center of the street, at a distance of about five ft. from the curb line. If a planting space of ample width is provided and if there is room for clearance between the tree line and the curb, or the sidewalk and the property line, the storm drain may be laid in such space. Where some of the substructures must be laid under the roadway pavement, it is preferable to locate the storm drain in the street rather than other utility lines for which the necessity for repair is more likely.

COMBINED SEWERS

Combined sewers must be provided to serve the requirements of both systems of the separate plan, and the design, therefore,

will be affected by the considerations heretofore listed under each system.

Quantity and Capacity.—The maximum capacity to be provided is fixed by the maximum rate for storm water discharge, which is to be calculated in the same manner as for storm drains. There is, however, this exception; as sanitary sewage and roof water is carried in the same pipes and the flow at all times contains sewage, in varying proportion to the storm flow, flooding or over-taxing of capacity will be followed by more serious results. The factor of safety used in fixing capacity, therefore, will have to be increased, as it will only be permissible to exclude the most excessive storms. Under some conditions even the maximum rate of rainfall will have to be provided for. The necessity of allowing for the maximum rate of rainfall will be increased where drainage from business districts is under consideration.

The rainfall rate to be provided for will vary from the maximum or heavy storms, occurring at intervals of once in five to ten years. The possibility of property damage and trouble by flooding must be balanced with the question of cost.

Consideration must be given and allowance be made for waste from street cleaning by flushing and flow from flush-tanks and similar sources. The design must also take into account the minimum flow, which will consist of the minimum sanitary discharge from the house fixtures plus leakage. Owing to the comparatively large size of the sewer, this flow will ordinarily be sluggish compared with that which obtains in the sanitary sewer of the separate system, where the capacity is more nearly adapted to the hydraulic requirements.

Velocities and Grades.—The minimum grade of pipe sewers of from 10 to 15 in. in diameter, should be such as will give velocities of not less than 3 ft. per second, when flowing full or half full. When larger sizes are under consideration, conditions obtaining under minimum flow must be investigated.

Where sufficient velocity cannot be obtained in the ordinary circular section, recourse must be had to special sections, such as the "eeg-shape", or the elliptical sewer, for the smaller sizes; and in any event, special attention must be given to the design of the invert in large sewers, with a view of providing for a sufficient depth of flow during dry weather conditions. At the same time the section must be so designed as to prevent deposits on ledges where the shape changes.

Depth and Location.—The flow line of combined sewers should be at least 10 ft. below the surface of the street, the depth being fixed at a required fall for the house connections. In business districts this should be increased to 12 ft.

The location ordinarily used for the combined sewer is the center of the street. Alternative locations in the alley or easement at the rear of the houses should, however, be inquired into and adopted if economical and advantageous.

Catch Basins.—Traps are generally provided on house connections, and like wise on catch basins or storm inlet pipe connections. On account of the relatively lower self-cleansing characteristic of combined sewers, catch basins are employed more often than inlets, by reason of necessity, and local practice indicates this. A trap may be provided either in the catch basin connection, or may be formed in the catch basin itself; the former is preferable.

SEWAGE TREATMENT AND DISPOSAL

General Considerations.—The term "Sewage Treatment and Disposal" covers the manner and method of the ultimate disposition of sewage. While it commonly refers to works providing treatment of sewage, it may furnish only a properly designed outlet into an open water course. It may, however, involve construction of extensive works designed to reduce the high content of organic matter, to a degree of purity—the so-called drinking water standard.

There is embraced in the consideration of this important subject, not only a knowledge of the various processes and methods, but also the application of them to the problem in hand. The object sought is the disposition of the sewage in such manner as will be sanitary, cause no offense or nuisance, which will not disturb the amenities, and which will not menace or affect the health of the community from which the sewage is discharged, or that of any other community in the locality. Whatever may be the requirements, the problem must be solved in the manner and by the methods most adaptable and effective to accomplish the desired results, and whereby the cost of construction and the cost of operation will be considered together and rendered as low as consistent with the desired results. Due regard must be given not only to the requirements of the present, but to the

conditions of the future, as they may be affected by growth, or by a change or raising of the sanitary policy.

It is beyond the scope and limits of this volume to cover in detail the proper selection of type of plant and its design. The subject is complex, highly technical in its several aspects, as it concerns the sciences of bacteriology, chemistry, hydraulics, and is a distinct and separate branch of the engineering profession. It is greatly affected by experimental and operative data of existing plants and deductions from lengthy investigations.

While there are but few who will question the necessity of proper sewage disposal, it is generally looked upon by those upon whom the expense falls, as an added and expensive burden, bearing no return or profit to the builder and installed only to satisfy the whims of state authority. There is, therefore, often a disinclination to do the right thing at all, with the result that it is frequently not done well or wisely, and that the cost of construction and operation is excessive. The owner is chiefly concerned in effecting disposal at the least cost, that the requirements of the State Health authorities be complied with—but he is vitally interested in a solution which will not in any way depreciate the value of his property.

It is the intention here to point out the principal methods and means of sewage treatment and disposal, with some information as to their application to various conditions and to indicate the extent and the comparative cost of such installations. It is well also to add a few words of precaution and advice as to the selection of the best adapted methods of treatment, and as to the selection of the site or location of the works. For the results of sewage treatment and disposal installations have not always been entirely satisfactory and failure is due largely to the lack of judgment in selection of type and to careless and inefficient operation.

Purposes of Sewage Disposal.—The decision to discharge sewage into bodies of water, requires consideration of the possible insanitary and harmful effects of such discharge, and of the means and processes which may be resorted to, to prevent such evils, or to confine them within reasonable limits. There is involved a study of the amount, character and condition of the sewage to be discharged; a proper conception of the character and extent of the various obnoxious and insanitary conditions which may result therefrom; the character and physical attributes and

condition of the stream; the nature and the uses of the stream; the means and methods of sewage treatment and disposal which are best adapted to prevent obnoxious or insanitary conditions, or to confine the affects within reasonable and permissible limits, consistent with local conditions and the extent of injury which may be suffered by the interests involved.

The following conditions may be created:

Physical effects in the vicinity of discharge, such as fouling and deposits of solid matters in and along the shores and banks of the stream; formation of banks of sewage mud offshore in shallow water and possibly in the body or channel of the stream; discoloration and turbidity at and below the point of discharge. All the foregoing constitute local nuisances generally objectionable in appearance, give rise to offensive odors, and may directly or indirectly effect the health of the community, and prevent the use of the water for public, industrial and private purposes. The conditions above noted will generally obtain in more or less aggravated degree in the vicinity of the outlet, unless there are unusually advantageous circumstances. The continuation of such evils are tolerated only because of the indifference of public opinion. The conditions above referred to are brought about chiefly by the floating and suspended solids carried in the sewage and are referred to as "local nuisances".

General pollution of the water course, or other body of water, constituting a condition of general nuisance—a term used to describe the effects of sewage pollution in the main body of the stream—may obtain a considerable distance from the point of discharge, and is to be distinguished from local nuisance. It is evidenced in a physical manner by floating matter, turbidity, discoloration, offensive odors and, in a biochemical manner, by changes in the character of the water, resulting principally by the reduction and in the most extreme cases, by the exhaustion of the oxygen normally contained in fresh water. In the many extreme cases the water of the stream may approximate that of sewage, and this condition may obtain not only in small water courses such as brooks, but also in larger streams and lakes. It may not directly concern the community from which the sewage is discharged, but its effects may be far-reaching and interfere with or prevent the use of the waters of the stream for useful and necessary purposes, and may be destructive to fish life.

Contamination of water supplies and of water used for such

purposes as bathing, boating, and for manufacturing and industrial purposes may also result; all of which are of vital importance to the health and welfare of the community. Such contamination may occur either in the vicinity of the point of discharge, or at points more remote. The question involved is not so much that the water is polluted, for the reason that most water courses are unsuitable for use as public water supplies without some degree of water purification, but that contamination may be of such magnitude as to render the purification or use of such water unduly expensive or unreliable.

To avoid any or all of the foregoing conditions being created, recourse must be had to that method, process, and type of sewage disposal works which will safeguard public health, and will prevent or restrict objectionable effects in a manner and to a degree commensurate with the rights and relative interests of the several users of the water of the stream. The particular works should be of such kind, nature and extent that neither the community discharging the sewage will be put to unreasonable expense or the users subjected to danger or unwarranted expense or burden in purifying or treating water for drinking purposes.

Character and Constituents of Sewage.—Sewage, composed of liquid wastes from domestic and industrial sources, contains organic and inorganic matters in varying proportions, in the shape of floating and suspended solids, and in solution. It contains enormous numbers of bacterial organisms and its presence as a polluting, contaminating or disease producing agency is identified by the presence of the bacteria B. Coli, an organism emanating from the human intestinal tract.

Chemical analyses of the sewage of various localities reveals a very wide range in its character, constituents and composition, which is caused by many factors and conditions, particularly the per capita use and character of water, the relative amounts and nature of trade waste, the extent to which street wash is admitted into the sewerage system, and the condition of the sewage with respect to age. Not only does the sewage of various localities show great differences but the strength and composition of the sewage in any particular sewer varies from hour to hour, and moreover the condition of sewage changes with time as the process of its decomposition proceeds. Sewage is therefore variable and complex.

The important characteristic of sewage is the amount and kind of solid matters it contains, a considerable portion of which is organic, and hence subject to decomposition, and the balance mineral matter. The solids are partly in suspension and partly dissolved or in solution in the sewage. The suspended matter is of particular significance on account of the part it plays in the creation of local nuisances in the vicinity of the outlet.[1]

Suspended solids are those which are removed from sewage or effluent by standard laboratory methods of filtration. That part which subsides in quiescent sewage in two hours is termed the "settling solids". Some of the suspended matter is so finely divided that it cannot be settled by ordinary settling processes, and is defined as colloidal matter, which is suspended matter so finely divided that it will not subside in two hours and will not pass through a parchment membrane in the ordinary process of dialysis.

The sewage of the typical residential community will generally contain less than 1000 parts per million of solids, and perhaps 600 to 800 parts per million may be taken as typical. Thus it will be seen that the solids constitute less than one-tenth of one per cent. of the total. About one-half of the total solids will be in suspension and the balance in solution. Then again, approximately one-half only of the suspended solids can be settled in two hours. It will be evident that the exact amount of the solids which can be settled out in ordinary treatment processes is of great importance, but that even though very efficient sedimentation or removal is obtained, and practically all of the settling solids thereby removed from the sewage, the effluent will still contain a very large portion of the putrescible organic matter, which is either in the form of collodial matter, but not susceptible to sedimentation, or in solution.

This then will indicate why some relatively simple processes such as screening and tank treatment of sewage, while they may be effective to correct local nuisances and the more obvious effects of sewage discharge, cannot be expected to prevent contamination of water supplies, unless further treatment is given. Residential sewage from small communities has this characteristic that the proportion of matters in suspension and settling solids

[1] See definition of terms used in sewage treatment: Report of the Committee on Sewerage and Sewage Disposal of the Sanitary Engineering Section of the American Public Health Association, 1917.

is relatively high compared to the sewage of large manufacturing cities.

Decomposition of Sewage.—Sewage undergoes a process of decomposition, accomplished by chemical, physical, and bacteriological agencies, all of which play an important part and which account for the varying conditions and characteristics. The process in its simplest terms, consists of the breaking down of the organic matter in solution and suspension and resolving it into stable compounds, which is finally accomplished by the action of bactèria, both with and without the presence of oxygen.

An important characteristic of the process of the decomposition of the contained organic matter of sewage is the consumption of the oxygen contained in the sewage and in the water into which it is discharged. Both the strength of the sewage and the degree of decomposition which it has undergone, can be measured in terms of the amount of oxygen required for the completion of the process of oxidation.

The process of decomposition of sewage is marked by the following characteristics:

Beginning generally in the collecting system, the solids are broken up by mechanical action, some becoming suspended matter and some going into solution; the oxygen contained in the water begins to be absorbed by the organic matter, first by the organic matter in solution, and later by the suspended matter; this is continued as the breaking down process of decomposition of the solids proceeds. When the oxygen in the sewage has been consumed and the decomposition of the suspended matter begins, which may take place in about six or eight hours, the sewage may be said to be stale. The bacterial agencies which bring about decomposition work either with the presence of air, in which case the process is one of oxidation, and is termed aerobic; or in the absence of oxygen, the bacterial organisms in this case being termed anaerobic.

Final decomposition, without nuisance, can be brought about only by complete oxidation, and can be effected either by the discharge of the sewage into a body of water, the oxygen content of which is sufficient to complete decomposition by oxidation, or by accelerating the process of oxidation in treatment plants by artificial means.

Disposal by Dilution and Diffusion.—Dilution in a body of water is a natural process of disposal. To be satisfactory, it

must be carried out without local nuisance in the vicinity of the outlet, and must not contaminate or pollute the waters of the stream in such manner as to violate reasonable sanitary requirements. The ability of the body of water to handle the burden placed upon it by the discharge of the sewage will depend upon its condition with respect to pollution from other sources, its volume, depth, character of its banks and shores, and the velocity and volume of its discharge.

Many instances may be cited of the self-purifying abilities of water courses into which the sewage from large populations is discharged without seriously affecting their condition, use and appearance. This obtains because the quantity of oxygen available is sufficient for oxidation, and other conditions are favorable. The complexity of the problem, the variety of conditions, and lack of sufficient precise data, make it impossible to set a definite and general standard which will define the conditions under which disposal by dilution can be effected without objectionable conditions.

Authoritative Opinions.—As a criterion for the guidance of sanitary engineers, and with the understanding that local nuisance and contamination of water supply be avoided, the Passenger Transportation and Housing Division of the Emergency Fleet Corporation recommended the following:

"Disposal by dilution is generally satisfactory as regards freedom from gross nuisance, if the sewage is properly carried away from the shore and in shallow water through a submerged multiple outlet, and when the flow of the stream in extreme dry weather will provide a dilution of about 5 cu. ft. per second per thousand population connected with the sewers. Streams connected with public water supplies should receive special consideration."

The instructions issued by the Engineering Division of the United States Housing Corporation used the same amount.

This is an indication of the amount of dilution which will be required under average conditions but cannot be considered as of universal application, particularly where there is likelihood of the pooling of sewage during dry weather periods, and in the case of shallow streams having irregular courses and shallow depths.

When the stream below the sewer outlet is used as a source of water supply the question of pollution of such supplies must receive careful consideration. As the contamination of drinking water must in any event be absolutely avoided, we must be

guided by the conclusion that untreated sewage cannot be discharged into a body of water so used, if an unreasonable burden is thereby placed upon the systems of purification. The relative economy and effectiveness of sewage treatment versus water purification is involved, and in this connection the following conclusions reached by the Advisory Engineer of the International Joint Commission are of interest.

"In water ways where some pollution is inevitable and where the ratio of the volume of the water to the volume of sewage is so large that no local nuisance can result, it is our judgment that the method of sewage disposal by dilution represents a natural resource and that the utilization of this resource is justifiable for economic reasons, provided that an unreasonable burden or responsibility is not placed upon any water purification plant and that no menace to public health is occasioned thereby."

"It is our opinion that, in general, protection of public water supplies is more economically secured by water purification at the intake than by sewage purification at the sewer outlet, but that under some conditions both water purification and sewage treatment may be necessary."

As to the particular problem in hand, that of the pollution of the boundary waters between the United States and the Dominion of Canada, the Advisory Engineers concluded:

"While realizing that in certain cases the discharge of crude sewage into the boundary waters may be without danger, it is our judgment that effective sanitary administration requires the adoption of the general policy that no untreated sewage from cities or towns shall be discharged into the boundary waters."

In determining the advisability of disposal by dilution without treatment, it is necessary to know to what extent water used as a source of supply may be polluted. In this connection the standards considered by the Joint Commission and by the Public Health Service of the United States Treasury Department are of interest (See Chapter VI) and will aid in determining whether, under the given conditions, disposal by dilution without treatment is permissible.

Location of Outlets.—Where disposal by dilution is determined upon, the discharge of sewage and of the effluent of treatment works, require careful consideration in the location and design of the outlet, so as to prevent local nuisance at the shore and in

the vicinity of the point of discharge. The outlet should be located with proper regard to the depth of water, direction and velocity of current, and to such conditions as shoals, sand bars, or eddies. In most cases this will require extension of the outlet beyond the shore to such a point and to such depth that good diffusion or dispersion of the sewage can be obtained and maintained. The velocity of flow in the submerged outlet must be sufficient to prevent deposits therein and in the immediate vicinity of the outlet end, for this reason the size is generally made less than that of the outfall sewer. This will involve loss of head, and may require more than one line in cases where fluctuations in quantity of discharge are large. Multiple outlets also promote dispersion. In the case of combined sewers, or where a part of the storm water is admitted into the system an overflow is provided at the shore, the excess discharge passing directly into the water course.

The elevation of the approach of the outlet line must be fixed with proper reference to the elevation of the water in the stream, so as to obtain a free discharge and to avoid checking the flow in the outfall under ordinary working conditions, which would result in the forming of deposits in the sewer. This should also be located with reference to the possibility of the future construction of treatment works, so that the expense of future construction in that connection, may be minimized and the essential features, particularly the hydraulic requirements of future treatment works should be then provided for. The outlet should not be located in proximity to public highways, bridges, or dwellings, as injury to private or public interest may ensue, and nuisances, which otherwise might be relatively of little importance, may be a matter of serious moment.

Particular consideration is necessary where public water supplies take their raw water near the sewer outlet. Unless conditions are exceptionable and most favorable for thorough mixing of sewage with the water of the stream or other body of water, disposal without treatment should not be used if the water works intake is within several miles of the outlet. There will, therefore, arise problems of comparative cost as to the advisability of building long outfalls, or providing a reasonable degree of treatment.

Discharge into estuaries and creeks of tidal waters, present difficulties, due to the generally prevailing shallowness of the water

and the effect of the incoming tide. In such cases exceptional care will have to be taken so that obnoxious conditions will not be created; such may require treatment in tanks or screening, or storage in tanks, with discharge on receding tide.

Noreg Village and Yorkship Village, built during the War by the Housing Division of the Emergency Fleet Corporation near Camden, New Jersey, present good illustrations of the alternative methods. See Fig. 37 for illustration of plant for the latter place. The streams into which the effluent from these two towns discharge were in many conditions similar. Settling tanks, with provision for separation and removal of sludge, were provided for Yorkship Village, which has a population of about 8500 and discharges its sewage into a branch of Newton Creek, a small tidal stream or estuary. In the case of Noreg Village of much smaller size, the construction of treatment works was not deemed warranted, and here the discharge from a population of about 3500 is pumped into a storage tank, which is emptied upon the ebbing tide.

Processes of Treatment.—The methods and processes of sewage treatment, each of which is intended to accomplish the specific results, may be broadly classified as follows:

(*a*) Those to remove suspended matter by mechanical means, such as by sedimentation or screening;

(*b*) Those to remove the finer suspended matter and oxidize the dissolved solids;

(*c*) Destruction of the bacteria by disinfection, or sterilization.

The process of treatment which may be required or desirable may be a single process, adapted to the requirements, or it may consist of a combination of various processes.

The discussions of the various processes of sewage treatment which follow are necessarily limited to their main features and functions. Before entering upon these descriptions, it will be well to state that many of the definitions used in this connection are adopted from those drafted by the Committee of the American Public Health Association, 1917.

Screening.—Screens of various types are used as a mechanical method of removing floating solids and suspended matter. Coarse screens, which have openings in excess of 1 in. in least dimension, and of the bar and grating type, are used to remove the larger particles, either as preliminary to further treatment or before disposal by dilution. While serviceable in protecting

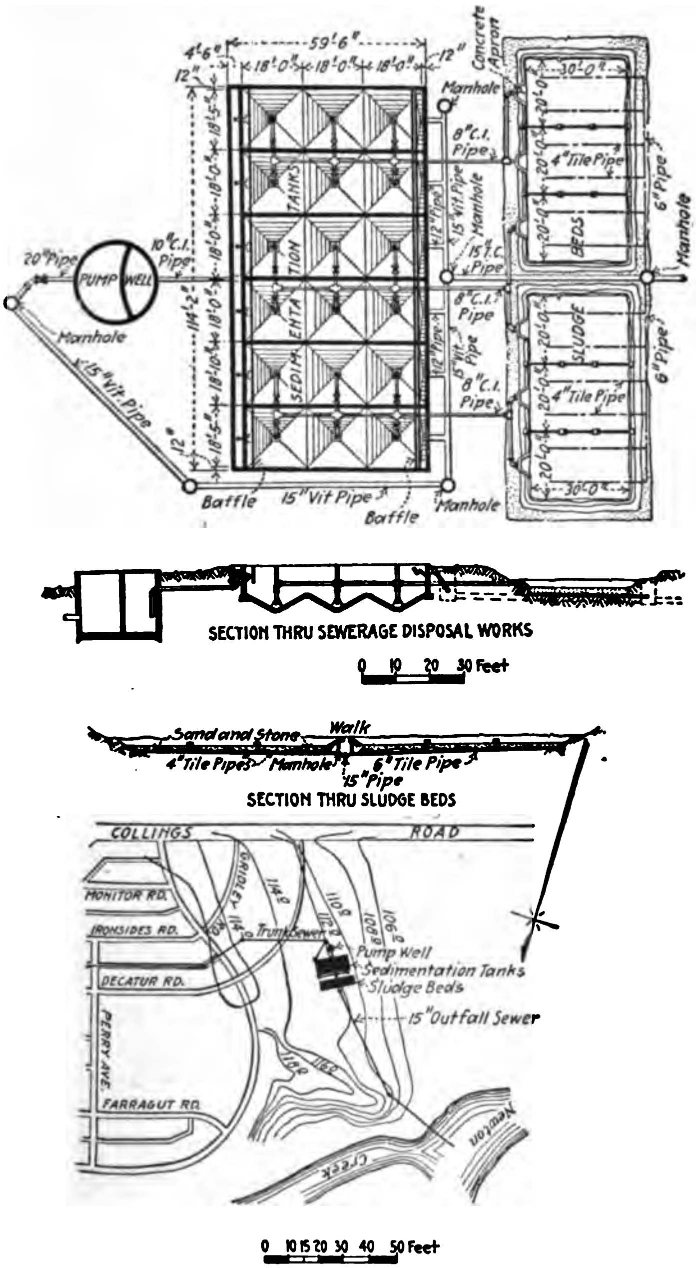

Fig. 37.—The Yorkship Village sewage treatment works, consisting of an automatic sewage pumping station, settling tanks of the hopper bottom type, and sludge beds.

pumps and preliminary to further operations, coarse screens are not generally useful in the disposal of sewage from the small communities.

Fine screens are those which have openings of 1/4 in. or less, in least dimension, and are being increasingly used, both as a preliminary process to further treatment, and under some conditions, as the sole method of treatment prior to discharge. There are various types of fine screens, including band screens, wing screens, drum screens, and disc screens.

Band screens are of wire mesh or bars, the screen operates on rollers on the endless belt principle, with provision for removal of screenings from the upper end.

Wing screens are usually of the bar type, composed of radial or curved vanes, rotating on a horizontal axis and depositing the screenings by a mechanical device.

Drum screens consist of cylindrical or conical screens operating on a horizontal axis.

A number of installations have been made in recent years of the Riensch-Wurl type of disc screen, which consists of a circular inclined perforated plate, set at an inclination with the horizontal and surmounted by a perforated concentric truncated cone of smaller radius. The perforations in the plate and cone are elongated openings or slots the width of which is dependent upon the requirements. The chief advantage of this screen is its comparatively large screening area, mechanical simplicity of operation and effective arrangement for cleaning.

Tank Treatment.—Tank treatment consists primarily of the detention of the sewage in a settling tank for a sufficient period of time to effect the removal by sedimentation of a considerable portion of the suspended solids. In some tanks, provision is made for digestion of the settled solids or sludge, so as to permit of its disposal without further treatment. In the simpler types sludge digestion is accomplished in separate tanks.

The simplest type of tank is the one story sedimentation tank, through which the sewage is passed at slow velocity and the accumulated sludge is drawn off at comparatively frequent intervals, sludge digestion being accomplished in auxiliary tanks.

The septic tank is a one story sedimentation tank, ordinarily rectangular in shape, from which the sludge is drawn off only at long intervals. There is to some extent a biological action in the tank, which assists in reducing the finer colloidal settling matter,

and there is some reduction in the quantity of sludge by liquefaction under the action of anaerobic bacteria. While many installations have been made in this country, it is no longer considered to be suitable for use in connection with oxidizing processes, as other types of tanks have taken its place where the removal of suspended matter is the sole object sought.

Installations consisting of tanks with hopper bottoms, built in units of two or more, will sometimes be found serviceable under certain local conditions. The sludge is held in the hopper bottom and the operation of the tank continued until such time as the sludge can be run off without causing offense. When a sufficient degree of digestion of the sludge cannot be obtained otherwise, the tank is thrown out of operation and the sludge permitted to decompose and digest, other units being meanwhile used. Unless the installation is very small it will generally be preferable to use separate sludge digestion tanks.

In the two story tank, sewage is passed through the tank in such a manner that it does not come into contact with the sludge; sedimentation and sludge digestion thus take place in the same tank without the effluent becoming septic or offensive. The Imhoff is the best known of the two story tanks. In this tank the suspended matter is settled out and automatically removed through slots and falls to the bottom of the settling chamber where sludge digestion takes place. The tank is so designed that the sludge may be thoroughly decomposed and rendered free of offensive odor so that it can be drawn off and dried without nuisance.

The percentage of the suspended matter removed in tanks of the various types varies through a very wide range, which depends upon the design and operation of the tank, and the character and condition of the sewage.

Filtration.—When a non-putrescible, or stable, effluent is required, one of the various filtration processes may be adopted. The sewage is passed through a bed of broken stone, sand, or other material and as a result of bacterial action taking place in the presence of air in the interstices and on the surfaces of the filter material, the organic matter in the sewage, in suspension and dissolved, undergoes certain biochemical changes and is oxidized and converted into stable compounds. The extent to which suspended matter is removed from the effluent and the bacterial efficiency are dependent upon the type of design, of which the following are in use:

Trickling Filters.—In this type, sometimes called sprinkling filters, the sewage is sprayed through nozzles, or distributed by mechanical device, upon a bed, several feet in depth, of broken stone or other coarse grained material, through which it slowly percolates.

Contact Beds.—These consist of water tight basins, containing a bed of broken stone or other coarse grained material, which is alternately filled with sewage and emptied, with an intervening period of rest to permit of aeration.

Intermittent Filtration.—This provides for filtration at low rate through natural or artificial beds of sand with alternate periods of rest.

Broad Irrigation.—This is one of the earlier methods, now generally abandoned, in which the sewage is applied to a specially prepared tract of porous soil, which in some cases is cultivated. This process is also known as sewage farming and land filtration.

Before the raw sewage is applied to any filter bed it should be passed through screens or tanks, to remove the settling solids and so prevent clogging of the filter beds and to lessen the burden imposed upon them. While the effluent from well designed and operated trickling filters or contact beds will be stable, it may be necessary to subject the effluent to subsequent treatment by secondary filtration or sedimentation, so as to remove the non-putrescible content of suspended matter and to more completely destroy the bacteria. Where complete bacterial removal is required, the effluent from the beds or from the final settling tanks should be disinfected.

Other Processes.—Activated Sludge.—This consists in the aeration of raw sewage, mixed with a suitable quantity of activated sludge which has been previously cultivated in such manner as to develop bacterial activity. This process, while one of promise, is still in the experimental and developmental stage.

Chemical Precipitation.—This is an earlier process of clarification by settling in tanks, combined with coagulation by chemicals, usually lime. It is no longer one of the customary methods. A modification is electrolytic action, which also has not come into common use.

Disinfection.—The bacterial contents of sewage or sewage effluent may be reduced by disinfection, or entirely destroyed by sterilization, with chemicals. Generally hypochlorite or liquid chlorine is used. Disinfection of screened or settled sewage may be utilized to accomplish a high degree of bacterial removal, either as an emergency measure, or to avoid the cost of more expensive installation, which may not be as efficient where

the destruction of the bacteria is the sole purpose. Complete destruction of the bacteria can be effected, when a very high standard is necessary, by sterilization of the effluent as a final treatment after filtration.

Selection of Method and Site.—The necessary degree and required nature of treatment and the type of plant best adapted to accomplish the desired results, will depend in any given instance upon what is required to prevent nuisance or contamination, as the case may be, and upon considerations of cost with due regard to physical requirements or limitations imposed. The degree and nature of treatment which may be required varies greatly; there is a certain latitude in the choice of type or method to secure a given desired result, and the adaptability of the various methods and types of installation varies with conditions.

Studies Required.—It therefore follows that before the method and type is decided upon and the site selected, there must be a careful investigation of the various factors and comparative studies of alternative methods. The following items will generally be included in such an investigation:

(*a*) Character, quantity and condition of the sewage, the nature of the treatment required, and the extent to which it should be carried to prevent nuisance or contamination.

(*b*) Cost of construction, operation and upkeep.

(*c*) Area, cost and availability of sites possessing the necessary physical requirements of size, available head or fall, and topography.

(*d*) Possibility of offense in the vicinity of the plant.

(*e*) Adaptability of immediate installation to possible future requirements as to capacity, or standards of treatment.

Screening or Tankage.—Where the object sought is the avoidance of local nuisance in the vicinity of the outlet or minimization of general nuisance in the water course, such as that arising from floating matter or deposits, either fine screening or tank treatment will generally suffice. Fine screening is neither as effective as tank treatment, nor as economical in the small units usually required in industrial housing projects. Adoption of some type of tank will generally be indicated.

One story tanks will generally be used, unless there is probability that filtration will later be required, in which case consideration should be given to two story tanks, such as the Imhoff tank. The conditions under which sludge is to be disposed of

will be a further determining factor in selecting the design of the tank, as some tanks produce a less offensive sludge than others. Proximity of the tank to dwellings, the permanency of the plant and other elements also must be considered.

Filtration.—Removal of the settling solids by fine screening or in tanks will not suffice in cases where the body of water does not have sufficient capacity to handle the effluent without conditions of general nuisance obtaining during all or part of the year, or when too severe a load would be imposed upon the water purification plants. In such cases, a stable effluent will be required, and filtration will be necessary. This will generally lead to the adoption of trickling filters, which being operated at a higher rate require less space than either contact beds or sand filters. If sufficient fall is available for their operation, or if pumping must in any event be resorted to, the trickling filter will be generally applicable, unless the site is not sufficiently removed from dwellings. In the latter case the contact beds may be preferable, even though costing more.

Intermittent sand filtration will occasionally be found economical for small installations, where land is comparatively cheap and the proper quality of sand is readily available, but the large area required and the cost of construction will generally exclude this type for larger installations. Where the plant must be built in proximity to dwellings, the contact bed may be preferred here also, owing to comparative freedom from odors and the fly nuisance.

The filtration process must be preceded by fine screening or tank treatment and where discoloration or suspended matter is to be avoided in the water course, must be followed by settling. If a more complete removal of organic matter and suspended solids is necessary so as to produce a very clear effluent of high standard, secondary treatment by filtration, followed by final settling, may be adopted.

Sterilization.—When contamination of water supplies is a factor, complete removal of bacteria will be necessary. This may be practically accomplished by secondary filtration and final settling, but the expense of such works for this purpose, where complete removal of the bacteria is the primary requirement, will be much greater than that of sterilization with chemicals, which further will be more dependable and effective. There will also be cases where tank treatment, supplemented by disinfec-

tion, while not producing a stable effluent, and not insuring the complete removal of the bacteria, will produce an effluent which will neither impose too heavy a burden upon the water course, nor endanger water supplies which are properly protected by purification.

Location.—The location of sewage treatment plants, particularly where they include trickling filters, in proximity to buildings is to be avoided; in any case, the plant should not be within 500 ft. of property to be used for building purposes. It must be borne in mind that there is a popular prejudice against sewage treatment plants, and whether such objections be fancied or real, every effort should be made to isolate the plant. The depreciation of property may well offset the cost of additional outfall construction necessary to reach a more distant site. Small tank installations, properly screened, may be located, if necessary, within not less than 500 ft. of dwellings, but the possibility of nuisance from odors and flies makes it advisable to locate trickling filters at least 1,000 ft. from dwellings.

The plant should be designed in units so as to afford flexibility in operation and to permit of extensions in the future. In this connection provision must be made for throwing part of the plant out of operation for repairs or alterations, and to take care of varying and fluctuating conditions of sewage flow and operating conditions.

CONTRACT PLANS AND SPECIFICATIONS

Contract Plans.—The contract plans should consists of a general plan showing the location of the system in its entirety, and a set of drawings of uniform scale and size, each covering a section of a sewer in plan and profile. A scale of 40 or 50 ft. per inch for horizontal, and of 4 or 5 ft. per inch for vertical scale, is recommended for usual conditions. The stationing should be carried across the sheet from left to right and should designate all changes in alignment and grade.

The plans should show the street and curb lines, street car tracks, existing substructures where there is any question of interference, the center line of the sewer, the offset from the curb, and the geometry of the alignment. The profile, on the distorted scale, should show the surface of the ground on the center line of the sewer, and the established or finished grades of the street, usually for convenience, taken on the top of curb.

Unless the character of the soil can be easily determined, test pits should be sunk along the line of the sewer at intervals and the location and character of material excavated should be shown on the contract plan. Samples of the materials excavated should further be taken and made available for prospective bidders. There should, however, be a statement in the contract to the effect that while the results of the test pit excavations are furnished for information, the owner does not guarantee the actual conditions to be as shown on the plans.

The contract plans should further show in profile the flow and invert line of the sewer, location of manholes, the elevations on the invert of the sewer, particularly at grade points and at manholes; also the elevation at which the casting of manhole covers is to be set. The location and elevation of connecting sewers should likewise be shown, while location of the "Y's" for house connections need be shown in plan only, and likewise catch basin and storm inlet connections.

The size of the sewer to be constructed should be plainly indicated and any special or incidental construction noted on the contract plans, and unless covered clearly and fully in the specifications, the method of paying for such accessory or additional work, should be indicated in plain terms on the contract plans. Such items will include railroad crossings, special foundations, removal of existing and obstructing surface or subsurface structures, and any other work not implicitly included in the work to be done and the materials furnished per lineal foot of sewer, which is the usual basis of measurement for payment.

The location of all catch basins, storm inlets, manholes and appurtenant structures should be shown likewise in plan. It is also usual to show the type of pavement if there be an existing pavement to be removed and replaced.

Where there is participation by municipalities, or where the cost is to be assessed upon the abutting property owners, the contract plans should be drawn in conformity with existing regulations.

Care should be exercised in the completeness and accuracy of the preparation of contract plans, with a view of their later utilization as record plans, after having incorporated such changes as have been made in actual construction.

Specifications.—*Materials of Construction.*—Terra cotta pipe is used for all diameters up to 30 inches. The standard sizes

are as follows: 5-in., 6-in., 8-in., 10-in., 12-in., 15-in., 18-in., 20-in., 24-in., 27-in., 30-in., 33-in., and 36-in. Where 36-in. terra cotta pipe is used it is usual to protect it with a reinforcement of concrete, unless there is little probability of damage by traffic.

Reinforced concrete pipe is used for sections of 24 in. or larger in diameter, particularly sizes in excess of 30 in. Such pipe may be made on the site of the work where the size of the job warrants, or may be shipped from the place of manufacture. Monolithic concrete or brick masonry construction is also used for diameters in excess of 30 inches. Such construction is necessary where reinforced concrete pipe of required diameter and suitable cross-sections cannot be obtained at reasonable cost. Segmental terracotta block is also used for large sizes.

General Outline.—The specifications should clearly and definitely state the requirements and dimensions for each type of sewer and kind of construction. In each case there should be sections relating to the work included in the contract price, and specifications for the materials, workmanship, construction, incidental work, testing, measurement and payment. When the work is to be performed on the fixed price basis, there should be a definite division of the contract into items of work, so that measurement and payment may be simplified. Ordinary items will be included for the following:

Furnishing materials and laying or constructing each size and type of sewer; price per lineal foot.

Excavation and backfilling; price per cubic yard; (sometimes included in the price bid for laying the sewer).

House connections; price per lineal foot including specials.

Additional branches or specials; price for each.

Manholes, catch basins, and other appurtenances; price for each.

Sewer castings; price per pound.

Special foundations; price dependent on type of construction.

Street repaving; price per square yard.

Sheeting and bracing left in place when ordered by owner; price per M. ft. B.M.

Special items as railroad crossings, tunnel construction, junction chambers, etc.; price either lump sum or unit.

The specification will be simplified by the inclusion of general clauses covering materials and construction included in the several items.

CHAPTER VIII

COLLECTION AND DISPOSAL OF TOWN WASTES

Classification, Character and Quantities of Municipal Wastes—Methods of Collection—Final Disposal of Wastes—Summary and Conclusions

Introduction.—Considering all of the factors attending the problem of location, construction, housing and administration of an industrial or residential community or town, the problem of final disposal of all the worthless and dangerous material that is produced is one of considerable importance and should receive careful consideration.

The question as to the effect upon the health of the public, caused by imperfect methods of collection of garbage and refuse, is one that has been frequently debated, and is still an open problem to be solved in many of its aspects. But there can be no doubt that the comfort, convenience and happiness of any community depends to a large extent upon the removal of worthless, and exhausted matter. These have little or no value in themselves, but by accumulation become annoying and offensive and, if allowed to remain in the household, may become positively threatening and dangerous to health.

This subject is presented with reference to the requirements of industrial and residential towns, but the compilation and classification figures of quantities, costs and other factors may apply equally well to the larger settled municipalities of the third and fourth classes of population, where this question is one for present or future consideration.

CLASSIFICATION, CHARACTER AND QUANTITIES OF MUNICIPAL WASTES

For the purpose of this inquiry there are five classes of wastes to be dealt with. These are: Garbage, Rubbish, Refuse, Ashes, and Street Sweepings.

Garbage.—Garbage consists of waste of vegetable and animal origin, resulting from the manufacture or preparation of human

food in households, and from public and private buildings. It is putrescible in character, being composed of organic substances which permit decay and fermentation, more or less rapid according to surrounding conditions.

TABLE 34.—COMPOSITION OF AVERAGE GARBAGE AS COLLECTED

Moisture contained, and free water		70 per cent.
Solids, vegetable and animal		24 per cent.
Bones, grease and fats		3 per cent.
Foreign matters		3 per cent.
Total		100 per cent.
Average weight per cubic foot	46 to	50 pounds
Average weight per cubic yard	1,250 to	1,350 pounds
Quantity per capita per day	0.4 to 0.5 pounds in winter	
	0.7 to 0.8 pounds in summer	

TABLE 35.—MONTHLY VARIATIONS, IN PERCENTAGES, OF GARBAGE PRODUCED ANNUALLY[1]

(Data from Two Large Cities)

	Cincinnati	Borough of Richmond (N. Y.)
January	5.3	5.7
February	5.2	3.7
March	5.2	5.2
April	6.9	7.7
May	6.8	8.1
June	9.1	8.7
July	12.4	9.2
August	12.1	10.6
September	13.8	12.5
October	8.2	11.3
November	7.5	9.2
December	7.5	8.1
Total	100.0	100.0

[1] FEATHERSTON: Proc. 2nd Pan-Am. Sc. Cong. 1915–1916.

The figures in the two tables above represent the character and quantities of northern communities under normal conditions. Due allowance must be made for exceptional conditions.

Rubbish.—This comprises the discarded and worn-out articles and matters from households, including paper of all grades, rags, wood, boxes, mattresses, broken furniture, shoes, tin cans, metal

scraps, bottles or glass, etc. The largest proportion is combustible and when burned in incinerating plants takes the place of considerable amounts of other fuel. As rubbish may contain the germs of certain diseases, it should be destroyed or carefully sorted under sanitary conditions.

Revenue may be obtained from the sale of marketable portions, when the quantities are large enough to repay costs of sorting and baling.

Rubbish varies in weight, as affected by local conditions. The average weight per cubic yard in Boston is 160 pounds; in New York, 143 pounds; in Buffalo, 215 pounds; in Chicago and Milwaukee about 175 pounds. The average weight is thus six to seven pounds per cubic foot.

Technical analyses of rubbish have been made in several of the larger cities, with varying results. The following table, compiled from the Boston Refuse Station figures, represents the percentage of marketable parts in that city in 1906.

TABLE 36.—PERCENTAGE OF SALEABLE PORTIONS IN ONE HUNDRED PARTS OF REFUSE COLLECTIONS[1]

Paper, six different grades	74.5
Rags, clothing, bagging, twine	12.2
Carpets, four grades	3.3
Bottles, common and proprietary	2.5
Metals, iron, brass, lead and zinc	2.1
Tin, all sizes and kinds	1.4
Leather, shoes and scraps	1.9
Rubber, shoes, hose and mats	0.2
Barrels, whole	1.4
Other material	0.5
	100.0

Refuse.—The refuse produced in factories and manufacturing buildings comprises many kinds of worthless matters and does not usually come under the charge or control of municipalities, unless there be nuisance or complaints caused by imperfect methods of disposal, offensive to the public. When these wastes are liquid or semi-liquid in character, or of large volumes, their disposal is a matter for attention of Health Boards under the laws of the State. As a rule all refuse matters from private trade and manufacturing companies are disposed of at the plant where accumulated and at

[1] MORSE: Collection and Disposal of Municipal Waste.

the expense of the company. When incineration is the town method of disposal, many forms of trade waste are destroyed by arrangement with the town authorities.

Ashes.—This is the fuel waste from houses where wood, coke or coal is used, and does not include ashes from steam boilers or private manufacturing plants. Ashes usually contain some unburned coal, besides cinders, slag and dust. It is inorganic, and not offensive in handling except for fine dust. It generally can be allowed to accumulate without nuisance, if stored with care, and removed less frequently than garbage or rubbish.

The weight of ashes per cubic yard varies according to local conditions from 1,050 pounds to 1,350 pounds. This is from 40 to 50 pounds per cubic foot.

Street Sweepings.—The cleaning of the streets of a town is not usually considered in connection with waste collection, but there may be instances where street sweepings and refuse can profitably be made a part of the general collection and disposal system. Sweepings include all kinds of miscellaneous matters that cannot be carried off by the sewers. They will average 50 per cent. of sand, dirt, powdered stone and practically 50 per cent. of manure and horse droppings and other organic refuse, although the latter is becoming less with the growth in use of automobiles.

TABLE 37.—CHEMICAL ANALYSES OF DRY COMPOSITE SAMPLES OF GARBAGE, RUBBISH AND CINDERS[1]
(In Percentages by Weight)

Constituents	Garbage	Rubbish	Cinders
Carbon	43.0	42.4	55.7
Hydrogen	6.2	6.0	0.8
Nitrogen	3.7	3.4	0.6
Oxygen	27.7	33.5	2.4
Silica	7.6	6.5	30.0
Iron oxide and alumina	0.4	2.0	9.0
Lime	4.3	2.3	1.2
Magnesia	0.3	0.6	Trace
Phosphoric acid	1.5	0.1	None
Carbonic acid	0.6	1.5	None
Lead	0.2	0.5	Trace
Tin	Sulphides	Trace	Trace
Alkali and undetermined	4.5	1.2	0.3

[1] MORSE: Collection and Disposal of Municipal Waste.

When dried in fine weather and taken up by the wind, street sweepings are a nuisance to the public and a positive injury to health and property. It is claimed that the increase in catarrhal diseases at such times is noticeably above the average. Sweepings have some value for land fertilization where the cost of transportation is not too great; the value is now decreasing with the lessened use of horses.

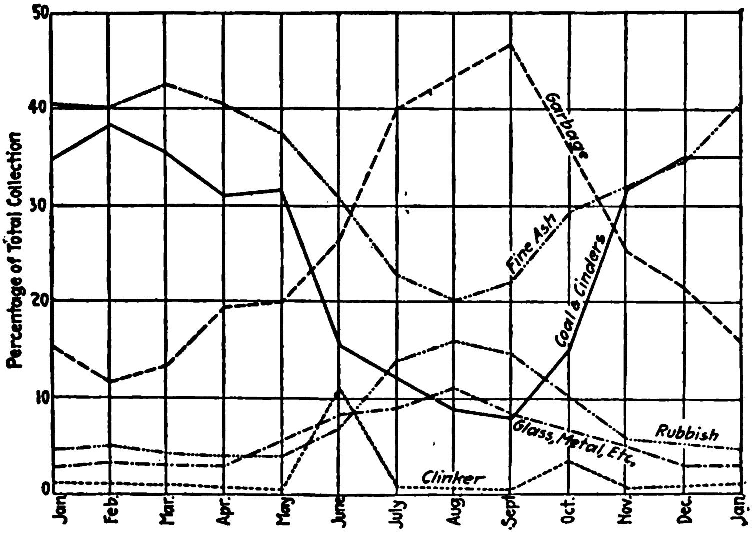

FIG. 38.—Monthly variations in the quantity of various municipal wastes.

Trade refuse from building operations, earth excavations, debris from buildings, or other construction work, is not a part of the municipal obligation, but should be disposed of at the expense of the constructor.

Chemical Composition.—A chemical analysis of dry samples of the three classes of waste is given in Table 37..

Quantities.—The quantities of all wastes vary with the character of population and the use of solid or gaseous fuels. Where the heating is by natural gas or cooking by this or artificial gas in summer, the quantity of rubbish is correspondingly greater. In towns using natural gas, the volume of rubbish far exceeds the garbage and is of greater weight.

There is also a wide variation in quantity during the year, due to seasonal changes. The monthly variations, by percent-

ages of the different classes of household wastes, with subdivisions of the classes is shown in Fig. 38. This is for a northern city with a population of 30,000.

The quantities of street sweepings depend upon the character of the streets and roads. From the usual street or dirt road, though packed and rolled, the quantity is largest, and less from brick paved and macadamized or asphalt pavings. The increasing use of auto vehicles reduces the amounts of street refuse. Tree leaves, branches and garden refuse sometimes form a part of this waste. The approximate weight of street sweepings is from 1,000 to 1,250 lbs. per cubic yard, an average cart-load, 1½ cu. yd., weighing 1,500 pounds.

METHODS OF COLLECTION

Location of Disposal Station.—The means of collection of the various classes of wastes are governed somewhat by other factors. Location of proposed disposal or loading station; routes of travel in town roads; proximity to that section of the town of least property value; and location with reference to possible present or future manufacturing or industrial plants, are all factors which come into consideration.

The general layout of the town should include a location for a waste disposal plant, where the largest number of useful purposes can be served. Hence, when this point is fixed, the collection methods should be made to conform to the necessary conditions with the least expenditure of time and money.

Separate or Combined Collection.—The method of collection adopted will depend somewhat upon conditions that cannot be definitely determined in advance. The general layout of streets and roads, distances to be traveled in transportation, location of place of final disposition, general character of population, disposition methods by one or another of the four different systems, the chances for recovery and sale of marketable portions, and the possibility of heat utilization from incineration methods are all factors which enter into the question of collection. The best method can only be finally determined when definite information is available.

The combined collection means the mixing of all classes of refuse in one load without separation. This is possible only when the mass is to be dumped into great pits or cavities for filling ground, or when the combined loads are to be destroyed

by high temperature destructors, which are generally too costly for equipment and maintenance. Another disposal of the combined waste is the conveyance by rail, from a central town loading station, to some point where it can be used for filling ground without danger or nuisance.

In some larger cities there are three separations of all household waste, garbage, rubbish and ashes. Each separation must have its own particular form of container, vehicle, or wagon, and attendants. On occasion the use of containers may be interchanged.

When garbage is separately collected, it is kept apart from other wastes, deposited in cans of capacity of 5 to 10 gal., and removed as required by the final means of disposition. When the garbage is to be fed to animals there must be particular care to exclude all forms of waste that may be objectionable or deleterious, such as medicines, strong cleansing compounds, fine glass or bottles, and some kinds of food waste that decay and ferment rapidly. The burden is upon the housewife whose assistance in this method is absolutely necessary. In a similar manner when the garbage is to be disposed of by the reduction process, the same precaution must be taken.

When the final disposal is to be made by incineration, there can be a mixture of garbage and small quantities of combustible refuse in one can, but the amount must be limited. After the preliminary draining of the surplus water, there is an advantage in using paper wrapping before putting into the cans. This prevents the fly nuisance, keeps the cans clean, and makes a better and quicker collection service. Here again the housewife must coöperate for the general benefit of all.

Garbage Collection.—As a general rule the garbage is collected separately from ashes and rubbish. A one-horse cart or small motor truck of 1½ cu. yd. capacity is in common use. This type of vehicle is of greater service for all general purposes of collection and for the use also by other departments of the town for collection of street sweepings and other general material.

The usual form is a steel body with sloping end, placed on a frame. This is mounted on a pair of wheels, which permits easy dumping, and covered with a sectional sheet iron cover. The weight of the cart is approximately 1,400 lb. and assuming that the average weight of garbage when separately collected is 1,250 lb. per cu. yd., the total weight of a completely

filled cart would be 3,300 lb. On level ground this load can be easily hauled by one horse and the cart loaded by one man.

Rubbish Collection.—It is difficult to make a collection of rubbish and garbage in the same cart or truck. The great volume of rubbish occupies so large a space that the garbage has very limited room. In some localities a longer body is used and a division made for garbage and refuse. But this is not a suitable method of handling.

The better method of collecting is by a wagon especially adapted for the purpose, about 10 ft. long and of the usual width, with high latticed sides, giving a capacity of from 5 to 7 cu. yd. per load. This is easily handled and loaded by one man. It may be discharged by special devices, such as a chain or rope being placed on the bottom of the wagon, which is attached to an overhead support, and when the team is started up the whole load is completely rolled out of the wagon.

Ash Collection.—In most places it is usual to use a type of rubbish cart with closed sides for the collection of ashes. One objection to its use is the great height to which the can must be lifted for emptying into the cart. The strain upon the collector is too severe to secure economical service.

A double horse wagon of the type described for garbage, but of a capacity of 3 cu. yd., or motor truck, is more economical for ash collection. All ash wagons should be provided with covers to prevent fine ash and dust from being blown out.

Can System.—In some of the higher class residential towns the garbage collection, mixed with the rubbish, is done by what is known as the can system. Each householder is required to produce and keep in a convenient place a can of about ten gallons capacity, with a tight-fitting cover, into which all garbage and a large portion of the combustible refuse is placed. The town provides double-deck wagons, each having a capacity of about seventy-two cans, and attended by one man. The can is removed from the household, placed on the wagon, and another clean, sterilized can put in its place.

The advantage of this method is the almost complete elimination of flies and odors, and, if the garbage is wrapped in paper for the purpose of incineration, there is very great saving in time and fuel in the process of incineration. In a town of 8,000 people where this method has been in use for some years, and where the character of the population is entirely residential,

without any factories, it has been found entirely serviceable. The collections are made once a week in winter and twice a week in summer, except for hotels and hospitals, where collections are made daily.

Contract versus Municipal Service.—There are four systems of collection, each of which has certain advantages in point of cheapness, but all of which are not of equal value from a sanitary point of view.

Individual Service.—By this system every householder takes care of his own waste in his own way, with the least possible trouble and cost; with no responsibility for after results, and with the only purpose of getting it off his premises in the shortest time possible. When the accumulation is so great as to become troublesome, a cartman is hired to take away the wastes.

The rubbish is cleared away in the annual spring cleaning, and from time to time as required. Inorganic matter is cleared away as accumulation requires. The retention of refuse until it becomes objectionable or offensive results in a greater expenditure when it is finally removed than if it were done by regulation of the town authorities.

License System.—In this case a number of cartmen are licensed to make the collections, upon payment of a small registration fee to the town. A route is established and a certain number of patrons are secured who are fairly well looked after. The dumping or final disposal of the refuse must be upon the collector's property, or at a place which is designated by the town.

The advantage is that the collectors, being known, can be detected if there is any infringement on sanitary regulations. But there is no remedy for the complaints of the householder, on the score of infrequent or bad collection service, or overcharge for the work. The cost as a rule is more than double the amount that would be paid by the town if it were done under the municipal methods of collection.

Contract System.—On this basis the city advertises for bids for collection of the whole or a part of the waste. This is a most convenient way for the authorities and an improvement over the license system, but it has some disadvantages and as a whole is less satisfactory than a municipal method. The contractor is often compelled by competition to accept the work at too small a margin of profit; thus he gives poor service and causes endless complaints.

The equipment and employees are not always of the highest class. The contract is usually for a short period. There is limited responsibility, and the purpose to do as little as possible at the smallest cost frequently prevails. There must be maintained a vigilant oversight by the city authorities, and frequent inspections of the equipment, methods of work and of the final disposal of the waste.

The householder benefits by a systematic collection at a somewhat lower cost, and if the work is done in a satisfactory manner, the city is relieved of a burden which it is often unwilling to accept. This is the system employed by a large number of municipalities, and may be said to be a typical American system of collection.

Municipal Service.—In this case the city provides and maintains its own equipment and employees. This is usually at a somewhat greater cost than by the contract system, but, by efficient superintendence, the results are far more satisfactory. The responsibility is upon the city's designated official, and by him distributed through his associates, so that poor work can be noted and corrected without loss of time. The equipment and employees may also be used in other departments of the municipal service, thus dividing the expense. The whole force, with a good executive, if kept from political interference, can be brought to a high state of efficiency and will take pride in the work.

The growth of municipal service in the collection of wastes is very marked in the past five years, due, perhaps, to the commission form of city government. The work has thus been kept more free from political control, and more directly under the observation of the commissioner in charge.

Comparative Cost.—The data, for tabulating the relative costs of collection service by one or the other methods referred to, is difficult to obtain and not always reliable. A comparison was made some years ago concerning the cost of garbage collections by the contract and by municipal service. In 15 cities of the first, second and third classes, this cost by contract was twenty cents per capita per annum; in 15 cities of the same classes, with approximately the same population, where the collections were made by municipal service, the cost was twenty-five to thirty cents per capita per annum. These should now be revised, owing to increased prices of labor and material, and the figures

should probably be thirty-five to forty cents for contract and forty-five to fifty cents for municipal service.

FINAL DISPOSAL OF WASTES

Whatever method may be ultimately adopted by the town for collection of waste, the matter of final disposition should receive careful consideration at the same time, as each affects the other. A thorough and accurate study should be made of all local conditions in each individual case. The fact that there is a continual agitation in a large number of municipalities and communities for a more economical, definite and better method of waste disposal, emphasizes the need of more care and foresight.

The government reports for 1919 show that 22 per cent. of all third class cities and towns in Pennsylvania were contemplating changes in their methods of garbage disposal. This whole problem of collection and waste disposal should be treated as an engineering question like other municipal subjects, such as water, sewerage, lighting, etc., and not merely as a minor item in the administration of the local health department.

There are four means of final disposal in use, each of which have certain advantages, not belonging to the others; but also certain unfavorable conditions are unavoidable. These methods are: Earth Burial, Feeding to Animals, Reduction, for obtaining by-products, and Incineration, complete or in part. The last is generally applicable to all classes of waste, but the others to the disposal of garbage only.

Earth Burial.—This method is used when a community has at its command an area of ground sufficient to receive its putrescible waste for a period of years. It is buried, left to be oxidized and composted by earth covering. In this case a series of shallow pits, or trenches, from 18 in. to 2 ft. deep and about 5 to 6 ft. wide, are excavated, preferably on a side hill. The garbage is dumped and thinly spread, to an average depth of about 6 in., and covered with the earth of the excavation of the preceding day. This process is repeated from day to day, and requires a very considerable extent of ground, since it takes from nine to twenty-four months for the soil to oxidize and assimilate the waste before it can be again used.

It is not economical to employ this method unless there is a wide area of unoccupied ground not suitable for residences, and

not valuable for farming. It is the cheapest form of disposal and, by care and oversight in regulating the dumping and covering, it can be made entirely sanitary. The disadvantage is that in the winter season it is difficult to make excavation and provide necessary earth for covering. Also this method does not admit of any admixture of rubbish, since this does not decay so readily and occupies more room than garbage. Burial is one of the methods to be considered when cheapness of disposition is under consideration.

Feeding to Animals.—At the outbreak of the War, the United States Government found that its food supply was entirely inadequate for the maintenance of its own troops and for export to the allied armies. Thus a call was sent out urging the feeding of garbage to hogs, in cases where it would not interfere with actual comfort and health of the people. The result was that a large number of persons introduced individual hog feeding on their own premises, without regard to the existing ordinances against this practice in communities. "Pigs for Patriotism and Profit", became a fad and fashion that lasted only through one experiment for individuals. But it had the advantage of demonstrating that there was a very great waste of food in households and that there is some value in garbage when collected under regulations and fed to swine under observant and sanitary control. Many towns contracted with individuals for the disposal of the garbage by this method, and some of the largest cities of the country have instituted hog feeding on a scale which demands the expenditure of large sums for ground, buildings, and operating expenses.

There is an undoubted value in separated garbage, but it implies additional trouble to the householder, in that it must be kept apart from all foreign substances and delivered at regular, stated intervals before fermentation has set in. A town may establish, through the agency of a private contractor, a hog feeding farm and by this method receive a return for the separated garbage, which can be used to defray at least a part of the other expenses of collection and disposal. When the garbage is sold by a town for feeding, there should be a definite understanding, as a part of the contract, as to the methods of handling and feeding, care of hogs and prevention of disease, and sanitation in building construction and grounds. All of these points were urged and enforced by the United States Government and should

now be followed in all communities where garbage is sold or given for feeding.

Prices for garbage depend almost entirely upon local conditions. In three of the largest cities the price paid per ton is about eight times the market price per pound for hogs on the hoof in Chicago. This represents about $1.30 per ton. In other cities the price paid is from fifty to sixty cents per ton for separated, clean garbage. Many of the New England towns receive a very considerable sum from the sale of garbage, at prices running from $0.50 to $1.10 per ton. The latest government report shows that the prices paid by contractors during the last year of the War for the garbage from the camps and cantonments was about one cent per pound. This was unusual and was due to the better quality and cleaner condition of the garbage.

In considering disposal methods for any community, hog feeding should be considered; but in general there should be five to eight tons per day to make this method worth while from a financial standpoint.

Reduction.—This is the treatment of separated garbage by steam in closed tanks, for the separation of the vegetable and animal oils and fats, and the recovery in a dry condition of the residuum for use as a constituent of fertilizers. This process to be successful, requires twenty-five tons and upwards per day of clean garbage unmixed with foreign substances. The great expense for patented machinery and special apparatus, the cost of upkeep and maintenance, the fluctuating prices for the products, together with extreme liability for explosions and fires from dangerous gaseous compounds, necessary for use, make this method beyond the reach of any except the larger cities of the country, or those having a population of 50,000 or more.

With few exceptions all of the reduction plants of the country are owned or controlled by strong combinations of capital, and carried on as a private business investment. The experimental smaller plants for towns of the third and fourth classes have not been found satisfactory. In the case of the industrial or smaller residential communities, this process is regarded as too expensive for consideration.

Incineration.—There is no form of refuse material that fire will consume that cannot be destroyed in properly designed and well operated incinerating furnaces with economy of fuel and

labor and with complete secondary combustion of smoke fumes and odors from burning substances.

Since the beginning of this method (in 1887) there have been a large number of cremators, incinerators, and destructors, patented or offered for use of municipalities. Perfection in design, economy in construction and operation, and sanitary performance have been claimed for each. Many have failed for various reasons, but experimental furnaces are still being developed.

Type Required.—When the final disposal of waste is to be accomplished by incineration, there should be selected a type which has a record of successful use under all conditions. The construction must be durable, of the best material, with a capacity suited to present and future conditions.

The furnace must be capable of destroying the whole output of combustible matters and a large proportion of ashes and street sweepings, if required, in a given time, with the utmost economy of fuel and labor and without causing offensive smoke, odors or fumes of combustion in the plant itself or the surrounding neighborhood. The plant must be arranged to receive and unload the collection wagons without delay, and must have convenient arrangements for separation of the different classes of waste for subsequent treatment, if this is required.

Capacity.—This will depend upon the present and anticipated future population and also upon the character of waste to be consumed. The design should be of the best approved type, though the furnace may be of small dimensions, and built at low cost for present uses, but capable of addition of other units at relatively small expense.

Beginning with an industrial town of 500 population and a small, inexpensive incinerator, the same design and methods can be extended indefinitely to larger plans, with equal efficiency.

General Purposes.—When the waste production includes garbage and rubbish, from either separated or combined collections, the incinerator is designed for disposal, during daylight hours, of all the daily wastes. This means that if other ways of garbage disposal, as reduction, or feeding, or transportation for dumping, should fail at any time, then the town would have means at hand to dispose of the waste by incineration.

With an incinerator of suitable capacity, any town is independent of all other methods of garbage and rubbish disposal, if

occasion requires. This applies to disposal of all animal bodies and certain forms of trade wastes, if necessary.

Rubbish Only.—In some communities the gathering and sorting of general combustible refuse is carried on for a revenue from recovered marketable material. The town builds the refuse utilization station, including an incinerator in its equipment, and collects the rubbish and delivers this to a contractor. The latter operates the plant, recovers all saleable material and pays the city pro rata on the volume of material sold.

It is not an expensive installation and is a source of constant revenue, besides avoiding the nuisance of dumping in any form.

Station Design.—When a town has provided a location suitable for a waste disposal station, there should be erected a building to enclose all operations of garbage and refuse reception and final disposal. The site should preferably be on a side hill where an elevation of 8 to 10 feet can be had on the natural incline of the ground. There should be storage room for at least one day's general collection, and all operations should be screened as far as may be from public observation.

The building may be of any suitable design and arrangement, constructed of any material that conforms to the general construction scheme of the town, and may be for temporary or permanent use, as desired. The dimensions of the building and incinerator are governed by the quantities to be handled of garbage and rubbish, not including ashes; room being provided for a rough sorting of the refuse for salable purposes.

SUMMARY AND CONCLUSIONS

1. In an industrial housing plan the question of collection, treatment and final disposal of all wastes which affect the health, comfort, convenience and happiness of the people must receive due consideration.

2. The problem must be studied with reference to local conditions in each particular case, with the intent of installing the best methods that skill and experience can supply.

3. When the methods of collection and disposal are determined upon, there should be a division of the collection districts into working units, a calculation of the quantities of each class of waste to be collected, the distances traversed, and the time occupied in collections.

4. It is advisable that the work be done by the municipal agency, either by the aid of responsible contracts for the whole collection, with the disposal under rigid regulations, or by the adoption of a municipal system of collection. The latter is preferable.

5. The work should be under the direct oversight of a special inspector, reporting to the official of the town having general charge of all the refuse collections and street cleaning work.

6. The regular collection service should be made at times which give the greatest efficiency, economy and public convenience, and with equipment best suited to the particular purposes. The collection should also be under strict regulations, to which the inhabitants must conform.

7. The chance of saving some part of the waste, and the recovery of revenue therefrom, should be carefully considered, even though the quantities may be small at first.

8. The location chosen for final disposal should include a refuse disposal station, with a building of approved design and a means for destroying all worthless matters.

9. The problem of refuse collection and disposal has now become an engineering question, requiring the advice of specialists, familiar with all phases of this subject. This should be brought to the attention of all communities where industrial housing is in progress or contemplated, as well as in larger places which are interested in securing the best improved methods and appliances that can be obtained for the solution of this problem of waste collection and disposal.

CHAPTER IX

GAS AND ELECTRIC SERVICE

Gas Service—Supply of Gas, Character and Sources—Utilization of Gas—Distribution System—Electrical Service—Source of Power Supply—Transmission—Distribution System—Utilization—Plans and Specifications—Illustrations of Installations

GAS SERVICE

Introduction.—One of the problems confronting the builder of an industrial housing development is that of providing a gas supply for the homes. While gas can probably not be classed as a necessity in the same sense as a water supply or sewerage system, and is no longer the usual means of lighting, it is by no means a luxury. Families which have once become accustomed to the use of this convenient fuel are most reluctant to forego its comforts. This should be given due weight in considering the relative economy of fuel supplies as they affect the cost of the project.

Advantages of Gas Service.—If a community is to be so situated that gas will be available, and the cost such as to allow its use for heating purposes, its advantages over use of other fuel may be most fully realized—even with restricted service. A gas supply means the abatement of the smoke nuisance—the inconvenience of delivery of coal avoided—dust and dirt in the houses reduced to a minimum—easier control of fires, allowing more uniform temperatures to be maintained—and the elimination of storage space for coal permitting more extensive use of cellars. The householder profits from the elimination of the operating labor and the handling of ashes, and is relieved from the necessity of securing and storing fuel in advance of the season.

No hard and fast rules can be laid down as to the advisability of including gas service as a part of the development. This is dependent almost entirely upon local conditions and must be determined for each individual case.

SUPPLY OF GAS—CHARACTER AND SOURCES

The supply may consist of either natural or artificial gas or a mixture of the two. In many parts of the country, where natural gas is available but not in sufficient quantities to meet the demand, artificial gas is being successfully mixed with it for general use. The gradual exhaustion of the supply of natural gas and the increasing demand for this convenient fuel forecasts a wider use of a mixed gas.

The mixing of natural and artificial gas produces a fuel having a higher heating value than artificial gas, and at the same time usually results in the mixture being sold at a lower cost than it would be possible to market either gas separately. Eventually, owing to the different heating qualities, the present volumetric basis on which gas is bought and sold will likely be replaced by the more rational method of measuring the service on the basis of the heat units supplied.

Natural Gas.—Natural gas is a mechanical mixture of several gases, the number and proportion of which vary with different localities. Its heating value averages in the neighborhood of 1150 B.t.u. per cu. ft.—practically double that of the best grades of artificial gas manufactured for commercial use.

Natural gas is still obtainable in many of the central and southwestern parts of the country, although in rapidly diminishing quantities. Its great heating value and usefulness, coupled with its diminishing yield, undoubtedly point toward conservation, higher prices and limitation of its use to domestic purposes.

Artificial Gas.—The most important of the gases artificially made are coal gas, carburetted water gas, producer gas and by-product coke oven gas. In the past, coal gas and carburetted water gas, either alone or in combination, have been most widely used for domestic consumption.

Coal Gas.—This is frequently referred to as "bench" or "illuminating" gas, and is manufactured by the destructive distillation of coal in externally heated air-tight retorts. It is primarily a mixture of a number of simple gases. The heating value of coal gas varies considerably, owing to the different grades of coal used in its manufacture, but a value of 550 B.t.u. may be assumed as a fair average. The approximate average yield per ton of coal is between 10,000 and 11,000 cu. ft. of gas, while the average yield of by-product coke ranges between 1200 and 1500 lbs.

Water Gas.—This is produced by the decomposition of steam, acting on incandescent carbon in the form of coal or coke. The heating value ranges between 300 and 350 B.t.u. per cu. ft. and for general municipal use this gas is usually carburetted or enriched by the introduction of crude oil in such a way that it becomes permanently fixed in the mixture. This, in addition to raising the heating value to approximately that of coal gas, is usually necessary in order to increase the illuminating quality so as to meet certain candle power requirements.

The danger of carbon monoxide poisoning accompanies the use of water gas, although when carburetted the odor of the oil used can be recognized in case of leakage, and ordinarily there is little likelihood of an accident resulting from this source.

Producer Gas.—This is made by passing both air and steam over hot coal, the volume obtainable from one ton of coal averaging between 100,000 and 130,000 cu. ft. of gas. Owing to the large percentage of nitrogen present, the heating value of producer gas is low, averaging in the neighborhood of 140 B.t.u. per cubic foot.

In the past, producer gas has been used chiefly for manufacturing purposes, the equipment for its production being located near the plant, so that the required transportation would be short. Gas produced in this manner is extremely dirty and, unless well cleansed before transporting, is likely to clog the pipes of the distribution system.

Coke Oven Gas.—This is one of the products resulting from the manufacture of coke in the by-product process. Its composition is quite similar to that of coal gas and the heating value ranges between 550 and 600 B.t.u. per cubic foot.

On account of the growing demands, lessened supply of natural gas and development of the use of collateral products, the use of by-product gas in mixture with natural gas is becoming well developed. It furnishes a means of prolonging the utilization of natural gas for a longer time than would be the case if it alone must be depended upon.

Source of Supply.—*Public Service.*—No doubt, in a majority of cases, the housing development will be located near an established community, and it will be possible to obtain a supply of either natural or artificial gas from the utility supplying this town. On the other hand, in the case of isolated developments, the high pressure mains of a company might be sufficiently close,

so that a supply could be obtained from this source. The supply might be secured by transporting the gas from a considerable distance, although it will generally be found that a gas company is quite reluctant to extend its system in order to provide service in this manner.

Industrial Supply.—It is quite possible that the agency promoting the housing project may own industrial plants, in which a gas is produced that can be utilized for the development, and in view of the steadily increasing cost of gas this possibility should be given careful consideration. The high cost of manufactured gas is largely due to the necessity of providing equipment sufficient to meet the greatest demand, even though the peak load usually exists only during a comparatively short period of the year. It is not economical to manufacture gas in quantities less than that for which the equipment is designed, and if gas is to be used for manufacturing purposes it is quite likely that it would pay to install the gas making plant for the industry sufficiently large to produce gas for both the plant and the housing development. Or if a domestic gas plant is used, build this large enough only to meet the average demand and reinforce the supply during periods of high consumption with gas from the industrial plant.

By-Product Ovens.—On the other hand, it might be that the quantity of gas produced in connection with other needs,—and this is quite common in connection with the by-product coke oven industry,—would be in excess of that required for the company's own development and the surplus could be distributed to nearby towns or other housing developments, and a profit thus realized. Similarly, conditions might be such that if a supply of gas is not available from the company's own plant, service could be obtained from another nearby industry.

There will be few cases only where a gas supply is not obtainable from a public service corporation, and in these days it is doubtful if it would be wise to build an independent domestic plant for supplying a housing development only. The relative economy of the different methods available can be determined only from a study of local conditions. In connection with some projects it will undoubtedly be found that gas cannot be economically supplied.

UTILIZATION OF GAS

Gas, both natural and artificial, is used in domestic consumption for heating, cooking and lighting, although for lighting pur-

poses it is being largely superseded by the use of electricity, and to some extent in cooking.

Heating.—The usual high cost of manufactured gas has prohibited its extensive use for domestic heating, but the development of more efficient burning devices and improved methods of manufacture will tend to increase its use for this purpose. In regions where artificial gas, only, is available, ordinary practice is to use it only in cooking stoves and under hot water heaters, the heating of the house being accomplished by the use of coal. This practice is now becoming common, even where natural gas is available, furnaces for the use of either gas or coal being installed, so as to guard against the contingency of the demand exceeding the yield of the gas fields during severe and long continued cold spells.

Natural gas as a fuel for house heating will usually be found as economical as coal, providing the proper equipment is used. With combination furnaces, coal can be used during the coldest months of winter when continuous heat is required, and gas during the fall and spring when heat is needed only during a part of the day. This will usually result in a saving, as the gas can be turned on or off instantly and used only when required. Even should coal be used in the furnace, gas fire places may well be used with economy and comfort for room heating.

Unless the town is a strictly residential development, the supply of gas should be sufficient to meet the requirements of small manufacturing plants, machine shops, etc. It may be used either as fuel under boilers or for the operation of internal combustion engines and some other processes.

Cooking.—Many of the same remarks as given under "Heating" apply here; but, even with high cost of artificial gas, there is a growing demand for gas and for appliances to use for cooking and household duties of various kinds. These may extend from the small hot plate burner to the more pretentious kitchen range, complete with oven and all appurtenances. Such use has almost become a necessity in the summer in warmer sections of the country and with row or apartment houses.

Lighting.—This has become largely obsolete, except in remote localities and where electricity for some reason has not been developed. As little attention is now paid to illuminants, even in artificial gas, it is customary to use incandescent mantels; thus any gas can be used.

Amount of Gas Used.—Abnormal peaks of short duration are characteristic of gas service and the proper design of any supply works will require a thorough study of the probable daily and seasonal variations. Space is too limited for full discussion of such variations and reference will be made only to the factors which affect the design of the distribution system.

Average and Maximum.—In most cases the design of the gas system for a housing development will require a determination of the maximum demand, only, that may be expected, in order that mains and distributing lines of adequate size may be provided. The volume of gas consumed will depend largely upon the character of the demand. Where natural gas is to be used for heating, as well as other forms of domestic service, the average for a residential development will be about 120,000 cu. ft. per year, or 14 cu. ft. per hour, per family. The amount for other gases will be proportionally greater, due to the lesser heating value.

The maximum demand will be about three times this quantity or 42 cu. ft. per hour. In estimating the probable consumption, however, even though the initial supply is to be natural gas, the probable future substitution of manufactured gas must be taken into consideration and allowance made, therefore, for a demand of 84 cu. ft. per hour.

Allowance for Artificial Gas.—A comparison of the probable maximum consumption of manufactured and natural gas cannot, however, be made solely on the basis of fuel values. The higher cost of the manufactured product, as compared with natural gas, tends to decrease its use as a fuel and at the same time increase the care and economy of the consumers. The consumption of the different gases, especially for cooking purposes, while depending directly upon their respective fuel values, is somewhat affected by the element of time. That is, while practically double the amount of manufactured gas is required to do the same amount of work per unit of time, as that accomplished by natural gas having twice the heating value, it does not necessarily follow that the work must be completed in the same length of time. The cooking may extend over a longer period and finally the increasing necessity of substituting artificial for natural gas will stimulate the perfection and efficiency of heating and cooking devices.

Considering these factors, a maximum rate of use of 60 cu. ft.

per hour may be assumed as sufficient for both heating and cooking purposes on all occasions, and the pipe lines may safely be designed on this basis. These figures, however, apply to the middle and northern sections of the United States. For developments in the southerly regions the effect of the warmer climate upon the maximum demand should be taken into consideration. Where local conditions are such that gas will be used only for cooking and lighting purposes, the distribution system may be designed on this basis. Before this is done, however, careful thought should be given to the possibility of later abandonment of wood and coal in extreme cold weather with a resulting increased demand for gas for such purposes.

Transmission.—If the gas service is to be furnished by an outside agency the method of transporting the gas from the source of supply to the site is usually not one of the problems of the housing project. In the limited number of cases, however, where the gas supply will be furnished by a housing corporation, the principles affecting the construction of the transmission mains will need to be kept in view. The first consideration is the size of the pipe that will be required to carry a supply adequate not only for the initial but for the ultimate development.

Pressures.—In practically all instances where manufactured gas is supplied, the required distance of transportation will be short, and the pressures carried in the lines comparatively low. The latter may be obtained by the use of high-pressure storage holders, but this is now being largely superseded. The system which is gradually coming into use, consists of small rotary boosters, which may be regulated so as to hold the pressure uniform, regardless of the variations in consumption. In the transmission of gas, a moderately high differential pressure (the difference between the pressure at the inlet and outlet of the line) is required, in order to secure enough driving power to force the gas through the mains. This pressure is used up in overcoming the friction offered by the pipe to the flow of the gas. At the discharge end of line, where the gas is taken into a low-pressure regulator, the pressure may be as low as 1 lb. per sq. in., although somewhat higher amounts are desirable.

Pipe Sizes.—The problem, then, is simply to find the size of pipe that will be required to deliver the necessary amount of gas at the regulator stations, the initial pressure at the source being known. Various formulæ have been developed, and

although no two of these will exactly agree, the results obtained are comparatively close. The following formula[1] by F. H. Oliphant, is recommended for use in determining the flow of gas, or the required size of pipe, in high or medium pressure systems:

$$Q = 42A\sqrt{\frac{P_1^2 - P_2^2}{L}}$$

in which Q equals the quantity of gas in cubic feet per hour; P_1 equals gage pressure, plus 15 lb., at intake end of line; P_2 equals gage pressure, plus 15 lb., at discharge end of line; A equals the square root of the 5.084th power of the nominal diameter of the pipe; L equals the length of main, in miles, and 42 is a constant deduced from practical experiments. The specific gravity of the gas in this formula is assumed as six-tenths and for a gas having any other specific gravity, the result should be multiplied by the square root of six-tenths, divided by the square root of the specific gravity of the gas under consideration.

Kind of Pipe.—Wrought iron or steel pipe is more extensively used for medium or high pressure gas mains than cast iron pipe, notwithstanding the longer life of the latter. The former is not likely to break and more readily accommodates itself to settlements of the ground. Cast iron pipe is usually laid with lead joints, and steel pipe with either screw joints or couplings, the couplings being used for the larger sizes. The major portion of the gas lost in transmission occurs at the joints in the line; thus the shorter lengths of cast iron pipe contribute more to this loss, and particular care must be exercised in the laying of the pipe to make the joints, however they are constructed, as leak-proof as possible. Threads and couplings should be painted with a thick mixture of red and white lead before screwing together.

Recently the practice of welding the pipe together, end to end, by means of the oxy-acetylene flame has been tried and, while this method is comparatively new, it is claimed that it will eventually supersede all others. Practice has demonstrated that the strength and flexibility of the welded joints, if properly made, obviate the necessity of special provision in the lines for expansion. For steel pipe lines, with screw joints, provision for expansion is sometimes made by inserting sleeves, but the usual practice is to lay the pipe in a more or less irregular line. In the case of plain end pipe, the couplings allow for such contingencies.

[1] Handbook of Natural Gas—Henry P. Westcott.

Drips.—"Drips" for the collection of moisture should be placed at all depressions in the line. Standard drip pots or tanks are manufactured for this purpose, the main feature being a baffle plate, placed in the center, for intercepting the liquid in the gas, which, striking against the plate, drops to the bottom of the tank while the gas passes around. These drips or blow-offs must be kept free from water by frequent cleaning.

Regulators.—For low pressure distribution the gas is taken from the supply mains into the distribution system through regulators or governors, which reduce the pressure to whatever extent is necessary to meet requirements. If the pressure in the main supply line is over 100 lb. per sq. in., two regulator stations will be required, the first to reduce the pressure to an intermediate stage of 15 or 20 lb., and the second, or low pressure regulator, to step this down to meet the requirements of distribution.

The regulator station may be placed either above ground in a suitable structure, or in an underground vault, whichever may be best suited to local conditions. If placed underground, ample provision must be made for ventilation, in order to allow the gas to escape in case of leakage, and also to prevent freezing of the apparatus. In certain instances it may even be found necessary to heat the gas previous to reducing the pressure, in order to prevent the freezing of the regulator, although such measure will be found necessary only when excessive reductions are attempted.

DISTRIBUTION SYSTEM

The gas distribution system within the limits of a town consists of a series or network of distributing lines, connecting various main lines, the required number of mains depending upon the size and arrangement of the development. The services for individual consumers may be connected with either the mains or the distributing lines. The relative advantages of placing gas lines in easements or in streets, the economy of a single and a double system of low pressure mains in the streets, and the desirability of placing several utilities in the same trench has been discussed in another chapter of this book and further reference here will be unnecessary.

Gas must be delivered to the consumers at a comparatively

uniform pressure adequate for their needs, but more than this is excessive and unnecessary. Pressures must be limited, also, in order to minimize the possibility of danger resulting from leakage in the house piping or in burning devices. This comparatively low pressure may be carried in the entire system or a higher pressure may be used for distribution, and the required reduction made by means of small individual regulators installed in the service lines.

Each system has its advantages, but that best adapted to any particular development can be determined only after a detail study of the relative economy of each as affected by local conditions. The source from which the supply is to be obtained must also be taken into consideration.

Low Pressure Distribution.—Where gas is supplied directly from the distribution system, without regulation, the pressure carried in the lines is usually from 4 to 6 oz., as the best domestic service is given when the gas is delivered at a pressure of not less than 2½ oz. per square inch. Where the population of the development is to be in the neighborhood of 5,000, more than one low-pressure regulator will probably be required and in such cases the supply line is extended as required. Usually when several regulators will be required it will be found desirable to carry the supply line around the approximate boundary of the development, so as to form a belt line feeding system. The pressure carried in the supply main may vary from a few pounds to 15 or 20 lb. per square inch.

Regulators.—The regulator stations should be carefully located with reference to the center points of heavy consumption, and to the distribution of the load throughout the system. In the majority of instances, it will be found desirable to place the stations in underground vaults, so as not to detract from the appearance of the development. These may be placed either under the streets or under easements reserved for utilities.

The regulator should preferably be installed with a by-pass so that it may be "cut-out" for repairs and the gas flow temporarily controlled by hand, if necessary. Regulators, constructed with a double diaphragm, have been found to give the most satisfactory service, as the pressures may be thus more closely controlled. Every precaution should be taken to obviate the possibility of accidents resulting from failure of the regulators. Safety valves should be installed on the low pressure side of the

station to relieve the pressure in the distribution system, should the diaphragm of the regulator fail.

In case the gas should fail in the night, or be thoughtlessly turned off from the supply mains and turned on again without warning, serious accidents might result. To guard against this contingency all regulators should be installed with attachments for automatically closing the ports of the valves and to prevent flow of gas again until the valves are opened by hand. The material used in the construction of the regulator should be such as will resist any chemical action of the gas, especially where the supply is to be manufactured gas.

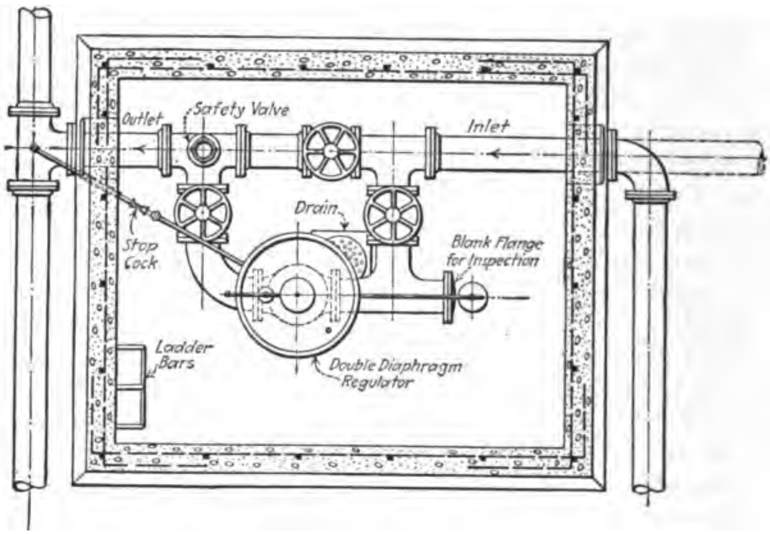

FIG. 39.—Plan of typical gas regulator station.

A typical installation of an underground station, using a regulator with double diaphragms, is illustrated in Fig. 39.

Size of Mains.—The design of low pressure distribution systems should make ample allowance for contingencies. The size of the mains should be liberal so that the loss of pressure between the regulators and the most distant consumers will be practically negligible. In common parlance, the lines should act more as reservoirs than as conductors, so that the pressure at the regulators may be maintained at about 4 ounces per square inch. This will tend to more nearly equalize the pressures throughout the system and will insure a more satisfactory service.

It should be remembered, however, that the period of maximum demand will usually exist only during a comparatively few days of the winter months, depending upon geographical location and the severity of the winter. In the majority of cases this period will probably constitute not more than three or four per cent. of the entire year and to meet this demand the pressures at the regulator stations may be increased,—providing of course that the supply of gas is adequate. The design of the system should be such, however that even in the most extreme cases, the required increase in pressure should not exceed several ounces. The loss of gas in a well designed low pressure system should not exceed five per cent.

High Pressure Distribution.—It is possible, however, and in certain instances desirable, to distribute the gas under a high or medium pressure. The low pressure required for domestic use is obtained in such a case, by the use of small individual regulators, placed on the service connections. In such a system, accidents resulting from the improper functioning of the individual regulators or governors are infrequent, especially when proper precautions are taken by installing safety devices in connection with the regulators.

Satisfactory service may be given in this manner and smaller pipe lines are possible. The saving due to the use of less expensive lines, however, is offset to a large extent by the cost of the attachments on the service connections to the consumers. This is especially true where the development is concentrated. On the other hand, considerable economy may be realized by such high pressure service, where the consumers are few in proportion to the required length of the distributing mains, or where service may be obtained directly from the medium or high pressure lines serving a district.

Aside from the saving that it may be possible to realize, high pressure distribution has the distinct advantage of making possible the delivery of gas to every house at a constant and uniform pressure, no matter what the distance. In addition pressures can be varied to meet individual needs. Where manufactured gas is used, high pressure greatly reduces the possibility of trouble from freezing of the lines. The possibility of such a method of distribution should be given most careful consideration.

Design of Distribution.—The use of wrought iron or steel pipe is recommended and particular care should be taken in laying to

secure tight joints, so as to limit the loss from leakage. In laying out the distribution system, care should be taken to eliminate all unnecessary bends in the pipe, so as to minimize the friction set up by a change in the direction of the flow of the gas. Although such refinement is not usually necessary, allowance in design for the drop in pressure, due to the friction of fittings and valves may be made by addition of a certain length to that of the straight section of pipe under consideration.

General.—The first consideration is an estimate of the population, and this must take into consideration the probable future developments and the directions which these growths may take. The character of the community—whether residential or largely industrial—should be considered in determining the average and maximum consumption. The general topography of the area under consideration, as well as variation in level, and its relation to the source of the supply, affects the design. Consideration must, of course, be given to the distribution of the demand for gas, whether equally spread over the district or unequally—and if the latter, in which direction the greatest quantities of gas will be needed.

The natural tendency of gas to rise should be utilized by arranging the mains so that the principal lines may run through the lower portions of the district, if this is possible. In the determination, or design of a system, this characteristic of gas should be recognized by making an allowance in considering the pressures. For this purpose, the gravitating effect of the gas can be assumed as equal to a column of water one inch in height for each vertical rise or fall of 100 ft. in the line.

Slope and Drips.—Gas lines should be laid on a slope, so as to provide drainage for the water due to the condensation of the moisture in the gas. The minimum allowable grade should not be less than 0.25 per cent. At all depressions, drip pots should be placed, and these should be inspected and cleaned frequently. In laying out and constructing the system, all the low pressure lines should be connected, and no dead ends allowed.

Valves and Bags.—In a low pressure system valves are not required in the lines, except at regulator stations and at those places where local conditions may make this provision desirable. For the purpose of repairing any section of the system, the gas may be shut off from this locality by means of gas bags, inserted through holes drilled in the pipes.

Depth of Laying.—Where natural gas is used, there is no danger of the lines freezing, and they may be laid at any depth determined by other considerations. With manufactured or artificial gas, however, the possibility of the lines freezing must be taken into consideration in determining the depth at which they should be laid. This is more particularly true of small lines which may become clogged through condensation and freezing of the water which is always carried in the gas. A depth of from two to three feet, however, will usually be sufficient, except in extremely cold climates. The difficulty experienced in connection with the freezing of the lines when artificial gas is used is largely done away with if the gas is distributed under a medium or high pressure.

Size of Pipes.—The required size of the medium and low pressure distributing mains may be determined by the use of the formula of Dr. Pole, $V = 1350\ D^2 \sqrt{\frac{\mathrm{PD}}{\mathrm{SL}}}$ in which V equals volume of gas discharged, in cubic feet per hour; D equals diameter of pipe, in inches; P equals pressure drop, in inches of water; S equals specific gravity of gas (air equals 1); L equals length of line in yards; and 1350 is a constant, deducted from practice and experiment. The pressure of a column of water one inch in height may be taken as equal to 0.577 ounces per square inch. The size of high pressure lines may be determined from the Oliphant formula given under "Transmission".

Services.—*Tapping Mains.*—In laying the gas lines, provisions such as "T's" are not necessary or desirable for service connections. After the lines are laid, holes are drilled, either before or after the gas has been turned in, by means of a tapping machine, and the service pipe connected by means of two street "L's". With wrought iron or steel mains, a saddle or service clamp will be required, as the thickness of the pipe shell is not sufficient for threading.

Size.—A 1¼-in. service line will supply an eight to ten-room house, and sizes smaller than this should never be used. Where the service line is not excessively long, a 1½-in. pipe should be large enough to furnish a supply sufficient for all domestic needs to the largest house. For industrial use, it will be necessary to determine the size of service line required to meet the individual circumstances. For schools, churches, stores, etc., a 2-in. service line should be used.

Galvanized pipe is not essential for service connection, and a considerable saving may be realized by the use of black pipe. All fittings, however, should be galvanized iron throughout.

Curb Cocks.—Stop cocks should be placed on all service lines, and a further economy may be effected by the use of stop cocks with galvanized iron cases instead of all brass stop cocks. Valve boxes, or "curb boxes", as they are usually called, should be placed over all service cocks. The usual diameter of the shaft of such boxes is 2½ in., and, while these are a standard product, care should be taken to obtain a box with a base of sufficient size, so that no weight will be transmitted to the service line. As the services will probably not all be the same depth below the surface, boxes with an extension or adjustable top should be used. A top with an arrangement for locking is a desirable feature.

Where the service is taken from a line in an easement at the rear of a lot, the location of the service boxes should be marked, so that they may easily be found in case it becomes necessary to shut off the gas in an emergency. This can easily be done by extending the top of the box a few inches above the ground and protecting it with a small concrete block. Such a block should be constructed with sloping sides and extended a sufficient distance in the ground to resist the uplifting action of frost. The hole in the center of the block should be left sufficiently large to allow the removal of the service box without disturbing the marker.

Slope and Drip.—Where possible the service line should slope toward the main so as to allow for drainage. If the slope of the ground is such that this cannot be done, it will be necessary to place a small drip pot at the cellar wall, to allow for the collection of condensation from the line.

In order to protect the pipe at the cellar wall and also to allow for easy removal, a galvanized iron sleeve several sizes larger than the service pipe should be used. The opening between the pipe and the sleeve may readily be closed after the line has been installed by caulking or cementing the opening.

Plans and Specifications.—Even though, in the majority of cases, a gas system will be owned and operated as a public utility, it will be desirable to include the design as part of the housing project, in order to coördinate with other utilities and street work.

Plans.—General and detail plans should always be prepared, the former to show comprehensive layout of the system—supply

and distribution mains, distributing lines, regulators, drips, valves and the location of all other structural features. Detail location of lines and structures may be quite readily shown on plans of other utilities, in connection with water lines and sewers. This will insure proper clearances and prevent interferences.

These plans should show profiles in order to establish grades and relation to the finished surface. Details of typical service installations should be prepared, as well as plans for the construction of regulator stations. These should show clearly details of piping connections to regulators and the location of all valves and safety devices. Cross-sections of streets, showing the depth of lines and relation to other utilities, will be found desirable.

Specifications.—The construction of lines may be handled in a number of different ways. Whatever agreement is made, the specifications should be such as to insure a satisfactory service. The rights of utility companies and obligations regarding maintenance of systems should be clearly understood and stated. This is particularly important as relating to repair to pipes under the pavements.

Technical specifications should cover the kind of pipe to be used, method of installation, sequence of construction considering other utilities, depth of lines, location of structures and the materials of construction. Methods of installing services should be clearly stated, the location and protection of service boxes, and the type and location of meters. With high pressure service, particular stress should be laid on the installation of house regulators. In short, all agreements and specifications should have in view securing an adequate and satisfactory service at a minimum of cost.

ELECTRICAL SERVICE

Introduction.—Electrical service for municipalities not infrequently introduces some rather difficult problems, which require careful consideration to the end that an adequate and dependable service at reasonable cost may be secured. It is important that that the installation may be made in such a manner as will not unduly detract from the appearance of the development, and also be capable of future extensions without manifest changes in plan of system.

Where service is furnished by a public utility company, there frequently arises a conflict of interest and opinion, the company

being guided by the inertia of established practice as to installation and operation and controlled very largely by cost factors. Further, the rates which may be charged are commonly regulated by State Utility Commissions and, if the cost of installation is greater than usual practice would entail, the company cannot obtain sufficient return upon the investment unless the builder of the project participates in the first cost of construction. Even then, particularly if the installation is a small one, the utility operating officials will not care to depart from their standard operating practice.

The builder's view point is based on the more intangible but nevertheless real grounds of appearance and attractiveness; not however lessening the value of good service. Having in mind the efforts he has made and the expense he has undergone to add to the amenities of the project, in the planning of the streets, lots, planting, grouping of the houses and similar features of good town planning, he is most desirous of not detracting from attractiveness by overhanging festoons of wires. Particularly he wishes to avoid those practices which tend so much to injure the good looks of streets, which can be eliminated at slight additional cost; sometimes even, it may be said, at a lesser cost than that of the established practice of the company. If the installation is to be attractively carried out, the advances in art or design may have to be initiated by the builders. It is therefore of value to point out the various ways in which this may be made to answer different requirements and conditions.

When current is furnished, either from a nearby industry or from a power plant, built especially for the development, the builder of the project can control the features of the installation. He is then interested in what manner and at what cost he can attain the desired results. The important questions are where can the service be obtained most cheaply and how can it be installed in the most satisfactory manner.

A working knowledge of the features and uses of the various elements of a complete electrical installation is essential, in order that a good practical scheme may be worked out. These include the following: the power plant; the transmission or supply line; the high voltage primary circuit within the project; the secondary system of low voltage, from which the house services are directly taken; the house services and meters; the street lighting circuits, and the various units of utilization of current.

SOURCE OF POWER SUPPLY

There are two possible sources of electrical energy between which it may be necessary to choose. If the project is adjacent to an existing community or power development, it may be possible to purchase power. If no existing power development is available, it will be necessary to construct a power plant, or design and utilize part of the power plant of the industry to meet the local requirements. These two possibilities are discussed briefly in the order named.

Purchase from Existing Utility.—Where existing power developments are available as a source of supply, it is usually more economical to purchase power than to generate it. This is especially true if the demand is only such as to require construction of a small plant. The question of relative dependability between two or more sources of supply should be given careful consideration. There may be more than one existing utility company able to furnish service. It may further develop that the service which can be furnished from an existing source, may be subject to interruption or breakdown, such that the construction of a local plant may be advisable, unless it is possible to secure a guarantee of continuous service from the utility company.

Three main factors go to make up a satisfactory supply; namely, continuity of service, constancy of voltage and reasonable cost to the consumer. Purchase of power from existing companies generally increases the possibilities of the first two and decreases the third. This method reduces the overhead expense of financing, engineering, construction, and managing the station and system. It places the responsibility for the continuity of service and the constancy of voltage with a large concern, which can well afford the expert advice and expense of installation most likely to produce these results.

Local Generating Station.—The alternative of designing and constructing a plant to supply the local requirements must be followed if it is not possible to purchase power from an existing public service or power company. Three general types of power plants should be considered, based on the type of prime mover. These are (*a*) the steam plant, (*b*) the internal combustion engine plant, and (*c*) the hydraulic plant, which is possible only under favorable surroundings.

Steam Plants.—The coal burning steam plant is the most common of this type. It will be necessary to choose between reciprocating steam engine and steam turbines for prime movers. A comparison of the economy of these two types of prime movers is not attempted here, but should be made on the basis of the particular plant in question.

The possibility of using by-product steam should be considered, since it often makes advantageous the construction and operation of a local power plant, even when there is an existing and available source of supply. Cases will arise where water pumping stations are to be built, or where the size of the development may warrant the construction of a modern high temperature incinerating or refuse disposal plant. In the first case exhaust steam may suffice for the operation of electrical units; and in the second, the direct steam from boilers of waste destruction units can well be utilized as a source of power supply.

Internal Combustion Units.—The internal combustion engine using natural gas, gasoline or fuel oil also offers possibilities as a prime mover. The natural gas engine is, of course, limited to territory supplied by this fuel. The gasoline and oil engines are not so limited. The recent developments in the Diesel type of internal combustion engine, using low grade fuels, forces the consideration of this type of prime mover, especially for isolated plants of small capacity.

Hydro-Electric Units.—If water power is available in sufficient quantity, it offers attractive possibilities in these days of increasing costs of coal, gas and oil. The cost of such a station, as compared to the other types and the time it would take to complete the development, would doubtless considerably exceed the cost and time of development of the other types. However, the freedom from full and excessive labor charges makes such a method worthy of consideration. The permanency and ultimate requirements of the project determine whether or not the increased expense will be justifiable.

Capacity.—The capacity of an electric station to care for the needs of a community depends so much upon the character of the community and the habits and customs of its people that average figures must be used with caution. In small villages the amount of power demand, for all purposes, may be 0.05 kilowatt per capita; but towns and cities with population of 20,000 or more need about 0.1 kilowatt per capita.

The size of a plant affects the cost very materially, the unit cost being much greater for small plants than for the larger ones. For plants of less than 500 kilowatts capacity the unit cost is found to be between $200 and $300 per kilowatt, while larger plants may be built for $200 to $100 per kilowatt.

TRANSMISSION

The word transmission as used here means the conveyance of power in quantity, at comparatively high voltage, from a generating station to a substation in the development. This is necessary only where the energy is purchased or generated at a distance from the site of its application, and generally obtains, if at all, with large developments. Three factors must be considered. They are:—Right of Way; Voltage and Frequency; and Line Construction.

Right of Way.—The transmission line may be located in a private right of way or on the public highway. The voltage employed and the type of supporting structures will largely determine whether or not the highway can be used. While the private right of way has certain advantages, yet for any except the larger and higher voltage lines, the advantages of using public highways are probably greater, because of the reduced expense in construction and the ease of access both for inspection and maintenance.

Voltage.—The voltage of the transmission line is determined largely by two factors, namely, the voltage at the power station, from which current is received, and the suitability of that voltage for the particular length of line in question. For example, it is entirely possible that the initial voltage of transmission or station from which the energy is received might be entirely too high to be practicable, by reason of expensive supporting structures and insulation required. On the other hand, it might be too low for economical transmission at that distance.

If the initial voltage is not suitable to the transmission in question, a transformer substation will be necessary. The standard frequencies in the United States are 25 and 60 cycle per second. Of these two, the latter is the more common because lighting installations are rather unsatisfactory when the frequency is lower than 60 cycles, although it is used in some cases because of its advantages in motor operations.

Line Construction.—The exact nature of the supporting structures can be determined only by consideration of all of the local conditions. These structures may be of the simple pole or mast type, of A-frame construction or of tower construction. The pole, mast, or A-frame types can be made of wood, steel or reinforced concrete. The tower type of supporting structure is ordinarily made of steel. The principal factors which determine the particular type are the cost and the suitability to the proposed location.

The choice of conductor size and material is largely a question of economy. The exact size will be determined by a number of factors among which are the amount of power to be transmitted, the voltage at which it is transmitted and the length of the line. It should be so selected that the annual cost, including fixed charges and cost of energy lost in the line, will be a minimum, unless the requirements of necessary mechanical strength and permissible voltage variation at the receiver end, due to change in load, dictate a larger size.

DISTRIBUTION SYSTEM

The distribution system begins at the terminals of the transmission line and consists of three main links, viz.: The substation, at which energy is stepped down from transmission line voltage to primary distribution voltage; the primary distribution system or feeders; the secondary distribution system.

Substations.—The substation is always necessary where energy is purchased or generated at a voltage higher than the primary distribution voltage. The particular type of substation and equipment which it must contain can only be determined by the consideration of the requirement of the community to be served.

Simple Transformer.—If only alternating current is to be distributed, then all that will be required is a simple transformer substation, which may be either of the outdoor or indoor type. Such alternating current type of substation is to be desired, both for reason of lower first cost and lower cost of operation.

Rotary Converter.—If direct current must be provided by the sub-station as well as alternating current, then recourse must be had to the use of rotating machinery in the substation, for the conversion of alternating to direct current. The rotating

machinery may be either in the form of a motor generator or synchronous converter, though for general purposes the former is preferable, by reason of its greater flexibility. In either case the introduction of rotating machinery involves not only additional first cost, but increased operating expense, as constant station attendance is necessary. In the case of the simple transformer substation, no attendance other than periodic inspection is necessary.

Primary Distribution.—The primary distribution system includes the lines, or feeders, by which the power is transmitted from a substation to the stepping down transformer nearest the consumer's premises. The study for such system involves similar considerations as for water distribution; namely, a determination of areas or zones of such use, and of capacity and extent as affecting economical design. The two principal items in connection with the design of the primary distribution system are:—the voltage and whether single-, two-, or three-phase current be used.

Voltage and Phase.—It is almost universal practice in America to use 2300 volts as the primary distribution voltage. Single-phase distribution will meet all the requirements of a lighting load. If a power load is to be supplied, then either a two- or three-phase system must be used. Of these the three-phase system is the more economical in line material and is most commonly used.

Location.—Three possibilities present themselves for the location of the primary distribution system. It may either be located on the streets, in the alleys or on an easement. Although it has been common in the past to use the streets, this is to be avoided, if possible, because of the unsightly appearances if overhead lines are used, and because of the interruption to traffic and disturbance to pavements when extensions or changes are necessary in an underground system. These objections indicate the use of alleys or easement construction.

Overhead or Underground.—The primary distribution system may be either entirely overhead as has become the practice in all small American communities, or it may be entirely underground, thus eliminating the unsightly appearance of poles and wires, or it may be a combination of overhead and underground. Overhead distribution is cheaper to construct and oftentimes makes possible the supply of electrical energy to

districts where the possible revenue would in no way justify more expensive construction.

On the other hand, overhead construction is undoubtedly objectionable, both from the standpoint of the appearance as well as hazard. In the downtown or business districts, where there is congestion of population, the hazards incident to overhead construction are somewhat greater and the density of demand may easily justify the placing of all the wires underground. In high class residential districts, the objection to overhead lines on aesthetic grounds may warrant the placing of the wires underground, even though purely economic reasons would indicate overhead construction.

Overhead.—If overhead line construction is determined upon, the factors which must be given consideration are the height and spacing of poles, the size of conductor and the location, number and size of distributing transformers, the number varying inversely as their size. Whether to use fewer transformers of larger size or a larger number of transformers of smaller size will depend almost entirely upon the density of demand.

Underground.—If underground distribution is determined upon, it is necessary to consider the various duct materials available, that is, vitrified clay, fibre or wood, as well as the number of such ducts. The choice of material for ducts involves a question of first costs, construction and maintenance and may depend upon whether or not it is desirable to place other utilities underground at the same time; as for example, telephone cable and police and fire alarm signal wires. Lead covered armored cable laid in trenches without employing ducts, is extensively used in street lighting circuits, and in running out from overhead construction in the rear of the houses to street lights. This should be remembered as the use of ducts is not necessarily implied in underground construction.

The conductor for underground distribution will be in the form of cable, but whether single or multiple conductor will depend upon conditions. The one essential condition for satisfactory underground construction is that the cable must be protected by a flexible metal covering which is absolutely impervious to water, and this condition dictates the use of lead covering.

The spacing of manholes for a duct system depends not only upon the distance between cross streets, but also upon the size and weight of cables to be drawn; the spacing varies from 150 to

400 ft. The manhole may be of the single compartment type, used exclusively for light and power cable or for telephone and fire alarm cables. They are usually built of brick or concrete, in rectangular or elliptical plan Some projects call for a combination manhole for telephone, fire alarm and lighting-power service, the two being separated by a fire proof wall. The combination manhole is not desirable where two-way lateral distribution is necessary.

Combination Circuits.—It is not probable that either of the foregoing methods can be used exclusively throughout the entire territory to be served. The underground system, in the business district and higher class permanent residential districts, might be combined with the overhead construction in outlying districts, thus making possible an economical distribution over much wider territory.

In working out the general arrangement of the distribution system, comparative studies and estimates should be made and due regard paid to the economic and practical features of the various methods previously described. A location might be found which was quite advantageous with regard to the primary and secondary circuits, and yet make difficult and expensive the location of the street lighting or house service circuits. While the underground installation is most satisfactory, in that it has no detrimental effect upon the aesthetics of town planning, yet its cost in many instances is prohibitive, and in many situations it will be looked upon as an undue and uncalled-for refinement.

A composite plan may be advantageously worked out, which for illustration, might include underground construction on parkways, main thoroughfares in the vicinity of parks, community centers, etc.; primary and secondary circuits located on easements in the rear of the houses; in some cases the primary circuits being carried on pole lines in alleys or easements and the secondary circuits on brackets attached to the houses, insofar as house location and grouping will permit. Street lighting of important streets and places, may be accomplished by using ornamental light posts with underground armored cable circuits. On minor streets, where property has less value, street lights may be attached to thirty foot poles, served by loop lines from the overhead lines in the rear of the houses.

Liability of lighting trouble and interruption of service renders the combination overhead and underground on the same circuit

an undesirable feature. It is much better, as indicated above, to put some circuits, in important places, completely underground and others, in less conspicuous locations, entirely overhead.

Secondary Distribution.—*Voltage.*—The service voltage for house lighting and for ordinary household appliances has been fixed by practice at 110 volts. Energy may be supplied at this voltage either by a two-wire circuit at 110 volts, or by a three-wire single-phase circuit, having 220 volts between the outside wires and 110 volts between either of the outside wires and the middle wire. All secondary wiring should be designed so that the drop between the transformer and any point on the distributing lines will not exceed three volts, a maximum of two volts being allowed in the house connections.

Pole Lines.—The secondary distribution wiring is usually carried on the same poles as the primary distribution circuits whenever these will serve. For this purpose additional cross-arms may be required, or the secondary wires may be carried on racks on the side of poles. It is sometimes desirable to distinguish between the primary and secondary wiring, either by characteristic construction or by using different colored insulators, in order that linemen may work on the lines without unnecessary risks. The standardized rules of the "National Electric Code" of the National Board of Fire Underwriters and the National Electric Safety Code, and the laws and regulations of state and municipal authorities should be consulted and followed for the purpose of conforming in these matters to the public policy in force.

It will probably be necessary to set additional poles for secondary distribution wiring in order to shorten the service leads from the pole to the consumer's premises. These poles usually need not be so high as those carrying primary distribution lines and need not carry cross-arms, and are consequently less expensive. Where the arrangement of buildings is such as to permit the same, secondary circuit or service connection may be carried directly from one building to the next, and thus serve a number of buildings. It is questionable whether the use of A-frames for carrying secondary lines over houses is as practicable as carrying the wires on brackets attached to the houses. This latter practice is quite general in the vicinity of Philadelphia, and was extensively followed by the Emergency Fleet Corporation in its housing work with satisfactory results.

Underground.—If primary distribution is underground, the step-down transformers will be located in manholes and the secondary distribution will also be underground. A single conduit system may serve for both primary and secondary distribution, but if the street is very wide this results in long service or lateral connections, which may justify the construction of a parallel conduit line on the opposite side of the street, for the purpose of carrying secondary distribution only.

Services.—Whether a separate service connection is necessary for each individual consumer or not will depend largely upon the arrangement and density of the buildings to be served. Under certain conditions a single service connection may serve several buildings, the buildings being connected by intermediate connections through frames on the side walls, or through the basement walls, or by overhead wires or brackets attached to the houses. This single service for two or more has the disadvantage that an interruption to a single service connection will cripple the service to all the buildings which it supplies.

Illustration of Types of Distribution.—Poles located on streets are an eye sore. Unsightly poles destroy an otherwise beautiful vista. The advisability of elimination from the streets resolves itself into this question: Are the advantages obtained by the removal of the poles from the streets commensurate with the added cost?

There are several ways by which this may be done. Many of the overhead wires may be eliminated from the street by carrying all wires, except those required for street lighting, on poles at the rear of the buildings in easements or alleys. Poles may be excluded from the rear of the buildings, by carrying the wires on brackets attached to the rear wall of the buildings thereby also making a financial saving. Such use of brackets is advantageous when grouping of houses permits. They are not only less unsightly than pole lines, but also effect a saving. The following paragraphs illustrate the estimated amounts of the differences in cost by use of several methods of construction.

Noreg Village.—Comparative studies and estimates were made by the Housing Division of the Emergency Fleet Corporation in connection with this installation near Gloucester, N. J., for the purpose of showing the differences in cost by use of varying methods of distribution of circuits. Service was to be supplied for a village of 488 houses, including street lighting, and power

for the operation of a small sewage pump. The costs given do not include transmission lines from a sub-station to the project. The statements of the various schemes and the total estimated cost thereof, of all circuits and appurtenances, as of February, 1919, were as follows:

Scheme A.—With street lighting and primary wires carried on the poles on the streets, secondary wires on pole lines in rear of houses, in conformity with local practice; estimated cost $17,600.

Scheme B.—Arrangement same as above, except secondary circuits carried on house brackets, instead of pole lines in easements; estimated cost $13,800.

Scheme C.—Street lighting circuits on poles on streets, primary and secondary domestic circuits on poles in rear; estimated cost $19,800

Scheme D.—Same as above, except house lighting, secondary circuits carried on house brackets; estimated cost $16,400.

Scheme E.—Street lighting circuits using cable in fibre duct, primary and secondary house lighting circuits, on poles in rear of houses; estimated cost $25,800; armored cable instead of fibre ducts would cost $900.00 less.

Scheme F.—Arrangement as above, except secondary house lighting circuits on bracket construction; estimated cost $22,400.

UTILIZATION

The applications of electricity to the service of any community may be classified as street lighting, house lighting and the various forms of power use.

Street Lighting.—*History.*—Numerous forms and types of lighting units have been employed from time to time in street lighting. The earliest was the open carbon arc, using solid carbons; this was later superseded by the enclosed carbon arc, which had the advantage of a longer burning period. Other types of arc lamps have been developed, including the magnetite lamp and other forms of flaming arcs of greater illuminating power and higher efficiency.

The incandescent lamp has also been developed to compete with the arc lamps for street lighting, but these were later superseded by the tungsten filament, "Mazda B" or vacuum type, which was in turn supplanted by the gas filled "Mazda C" type of tungsten lamp. This latter type has an efficiency as high as one-half watt per candle and is rapidly replacing all other forms of units for street lighting. Because of their smaller candle

power and cheapness, incandescent lamps permit of varied use and much greater flexibility in application than is possible with arc lamps. A larger number of small size units may be used to secure uniform illumination and greater attention may be paid to the decorative effect.

Too much attention cannot be given to the street lighting problem in housing developments, as the choice of street lighting system very often dictates the type of distribution which shall be used, and thus the effect upon the street appearance.

Methods.—The methods of supplying power to street lamps may be classified under constant potential (or multiple) and constant current (or series) systems. In the constant potential system, the illuminating units on any one circuit are connected in parallel precisely as in residence lighting. This system is rarely used except in special cases of very short lines, the chief objection being the large amount of copper required. This feature was early recognized and constant current systems have been developed to permit the use of a small sized conductor by connecting the various units on any one circuit in series. In this later system, any of the various types of arc or series incandescent lamps may be used.

Constant Current.—In the constant current system, a transformer automatically controls the voltage of the lamp circuit to maintain constant current, regardless of the number of lamps burning. When a lamp burns out, an automatic device, located in the socket of each lamp, maintains the continuity of the circuit.

Until recent years it was the custom to employ long circuits leading from the constant current transformers in the power station through a large number of lamps and back to the transformer, thus making a high voltage necessary to light all lamps to their normal brilliancy. The objections to this method were:

(*a*) High cost, due to the necessity of running separate wires for each circuit from a central point.

(*b*) The danger from coming in contact with poles or lamps when the line becomes grounded.

(*c*) That any accident to the automatic lamp cutout or break in circuit puts all lamps on that circuit out of commission.

To overcome these objections a method has been developed, in which the lamp current is derived from a 5 to 10 K.V.A. con-

stant current transformer, from the 2300 volt constant potential network. These constant current transformers feed 25 to 50 lamps on short loops of relatively low voltage. The advantages are:

(*a*) Lower cost, due to the use of the general distribution system.
(*b*) In case of accident to automatic lamp cutout or low voltage cable break, only a small number of lamps will be out of commission.

Types of Lamps.—Where a new installation is to be made and latitude in design is not restricted by existing conditions, the recommended type of installation is the highly efficient, high intensity gas-filled incandescent lamps. This may be used in either constant potential or constant current systems and is favored for reasons of economy and better illuminating effects. The lamps are made in candle power ranging from 50 to 1000.

Present practice indicates a tendency towards the ultimate replacement of all arc lighting units by some one of the incandescent types. This is largely accounted for by the lesser first cost, low maintenance and more satisfactory illumination of the incandescent type. Maximum illumination value can be obtained by those lamps which throw most of their light 15 degrees below the horizontal, and a minimum almost upward or downward.

Spacing.—Street lighting in general, aside from the type of unit employed, has undergone remarkable changes in recent years. Formerly the system of "spot-lighting", by locating units at each street intersection was deemed sufficient. The present practice indicates, for business as well as the residential district, a more uniform street illumination. This can best be obtained by using a larger number of smaller intensity units, spaced anywhere from 100 ft. to 250 ft. apart. These are preferably arranged on each side of the street, either opposite each other or in staggered rows.

The spacing and intensity of the lamp should be varied to suit the requirements. Good practice in this respect is indicated by the following: In business districts, 250 candle power lights, spaced from 100 to 200 feet apart; or 400 candle power lights, spaced from 200 to 400 feet apart. In residence districts, 100 candle power lights, spaced from 100 to 300 feet apart; or 250 candle power lights, spaced from 200 to 400 feet apart.

Poles.—In the early days of street lighting the entire distributing system was located on pole lines in the street, in preference to alleys and side streets, in order that a convenient mounting might be obtained for the lighting units. This is no longer considered necessary, as where proper street illumination requires closer spacing and more ornamental effect, there can be no reasonable grounds for retaining the pole lines in the streets. The light standard may be served from distributing lines on alley or easement location, either by individual overhead loops or armored cable in shallow trenches along property lines.

Various types of lighting standards or posts may be used, consisting of finished wood, concrete or steel poles; the latter two being designed for ornamental effect. These poles range anywhere from 10 ft. to 30 ft. in height, depending upon the spacing and the intensity of illumination desired. Poles may frequently be made relatively inconspicuous where necessarily placed on streets, by locating them next to the curb in the planting space and wires supported at such a height as to pass under the limbs of trees.

Transformers.—When overhead loops are used for the lamp circuits, they are served from constant current transformers mounted on the poles; if the distributing system is underground the transformers are located in manholes. If these constant current transformers are served by short separate 2300 volt circuits, terminating at the substation or some municipal building, where attendance is available, the lights are controlled by manually operated switches. Otherwise, the control is by an automatic switch actuated by a clock, installed at the transformer.

Residence Service.—*Lighting.*—House lighting at the present time has become well standardized, in that each house is provided with a two wire system and is served by a pair of 110 volt service lines. In larger buldings, the three wire 110–220 volt system is commonly installed because a saving in copper is secured by its use. In this case a three wire service is required. Either service may terminate in the basement or the upper floor of the house where the meter and cutout panel are located.

The average unit for most residential lighting is the 25 watt tungsten lamp and the power consumption for the average six or eight room dwelling will be from 10 to 20 kilowatt hours per month.

Power Application.—In the average residential development, power applications are usually limited to small fractional horse power motors for washing, ironing, cleaning, and cooking and heating appliances of various kinds. These, in the majority of cases, may be served from the low voltage distribution system. In the case of small shops and industrial applications requiring larger motors, the service is direct from the 2300 volt distribution system.

The largest size motor to be supplied from either of these systems depends largely upon the policy of the public service company furnishing the current and is governed by the maximum allowable voltage disturbance which a given size motor will produce. There may be other installations used, such as battery charging stations, school and industrial laboratories, etc., but these do not in general call for special service or conduits.

Miscellaneous Service.—*Fire and Police Call.*—For either fire alarm or police call systems, it is customary to purchase one of the several standard systems which are on the market. The installation of these may involve overhead or underground wiring, and logically follows the practice which may have been used in laying out the street lighting system.

The wiring may be looped from the call boxes by underground cable, overhead to alley or easement pole line construction. Or it may be carried underground in the same conduit system with the lighting circuits, if this plan be used for general distribution.

Telephone and Telegraph.—After having determined upon the design and location of the various lighting and power distribution systems, the telephone and telegraph wires and cable logically follow the same scheme. Lead covered telephone cable may be carried on main distributing pole lines, with clearance according to the requirements of the telephone company under whose jurisdiction the work may be done. The cable is usually carried to sectional centers, from which twisted pairs are run to the subscribers on racks on the low voltage distributing poles, or in some cases are distributed along the rear of the houses themselves.

Large installations, involving a great amount of telegraph distribution, make use of the telephone wires for this purpose, involving the simultaneous use of the wires for both telephone and telegraph. In any case the same system of poles or conduits can be used for telegraph distribution as is planned for the telephone system.

PLANS AND SPECIFICATIONS

In the preparation of plans for a proposed electrical system in any housing development, the drawings should show clearly the whole system, by distinctive lines and symbols, including street, block and lot lines and location of houses.

Instruction for Plans.—The general plan should show the following:

1. Location of the various circuits, and type of construction, as overhead or underground.
2. Location of poles, giving height and location of guys.
3. Location of substations or transformer stations.
4. Location of street lights, size and type of lamp.
5. Location and kind of house circuits.
6. Voltage, size and number of wires.
7. Location, capacity and type of transformers, primary circuit, branch line cutouts.
8. Location of lighting arresters, and secondary circuit branches.
9. Location, kind and number of ducts of underground lines, together with the location of all manholes, junction boxes and connections.
10. Location of police and fire alarm signal boxes; all wiring for same.
11. Location of telephone cables and twisted pair house service connections.
12. Detailed plans should likewise be prepared, showing the design and arrangement to be followed in overhead and underground construction, house line circuts, transformer mountings, street lighting fixtures, manholes, junction boxes, and other appurtenances.
13. There should also be detailed drawings of the substations or transformer stations required, showing all apparatus in and about the station, the detailed layout, with complete switchboard and station-wiring diagrams.

Specifications.—Where the installation is made by a utility company as an extension of the existing system, the general practice in regard to construction features can be followed, provided satisfactory results can be secured. Where a new installation is to be made, the construction specifications should be in detail, so as to insure satisfactory workmanship, materials and methods.

Such specifications should be built around the general plans outlined above, should cover in detail all the construction and installation requirements common to the best work. Quality and depth of setting, cross-arms and pin, details of poles; size

and insulation of wire, types and size of insulators, details of other units shown on plans should all be carefully specified.

Specifications covering street lighting should give details of pole construction and spacing, the type and method of burying underground trench cable and method of attachment to pole lines. The size of units in candle power for the different street locations should be indicated and an illumination curve showing the intensity of street illumination at different points between units should be provided.

ILLUSTRATIONS OF INSTALLATIONS

The general practice followed by the Housing Division of the United States Shipping Board, Emergency Fleet Corporation in several typical examples of electrical installations will be illustrated by the plans of layouts at Buckman Village, Chester, Pa. and at Atlantic Heights Development at Portsmouth, N. H. There is also described a layout for Loveland Farms, constructed for the Youngstown Sheet & Tube Company about the same time.

Buckman Village.—The installation at Buckman Village, which is illustrated in Fig. 40, was so arranged that to a large extent the various circuits were carried on pole lines, located along the alleys in the rear of the houses. The 2400 volt primary circuit was extended from the existing system of the utility company, and enters the project on a pole line, located on the main approach streets. The appearance of the project in this vicinity, which otherwise has many very attractive features, is depreciated to a considerable extent. In this case it was impossible to incur the additional expense of placing the incoming line underground.

The primary line extended from Keystone Street, a short distance from Eleventh Street, to an alley running parallel to the longer axis of the development and lying between Keystone Road and Meadow Lane. It is carried along this alley to Twelfth Street and thence up Twelfth Street to the boundary of the property. The location of the pole line on Twelfth Street is unimportant, as the layout is such that the houses do not front on this street. The domestic secondary circuit is taken off the overhead primary line and run on poles located in the various alleys, then over to the rear of the houses and thence distributed on house brackets. This latter arrangement is economical, owing

to the fact that buildings are of the row type, and the necessity for frequent service connections from the pole line is thus obviated.

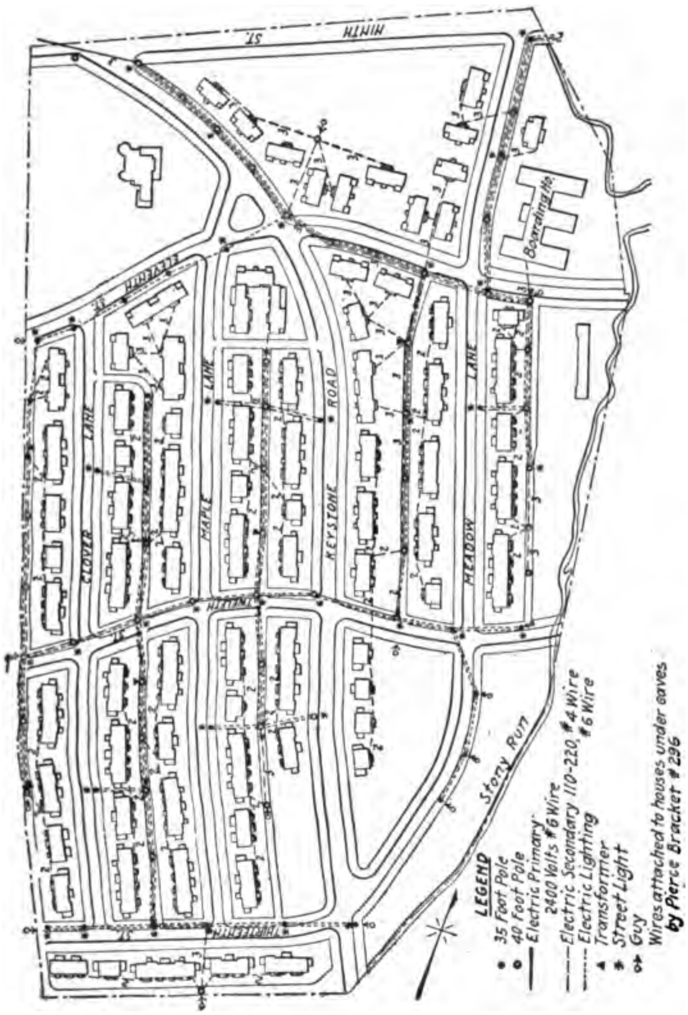

FIG. 40.—Plan of electrical distribution system installed in Buckman Village housing project of the Emergency Fleet Corporation; the circuits are largely located on easements in the rear of the houses or on unimportant streets; secondary distribution lines carried on brackets attached to the houses.

The street lighting circuits are carried on the same pole line as the primary and secondary domestic circuits. Where the latter lines are not located on the streets, the light connection was made by running overhead loops from the pole lines in the easements to the street. The loop lines were so located as to pass between

groups of buildings. Except where the poles were located on the approach streets to the project, the general effect of the installation is very satisfactory from the standpoint of appearance and at the same time no additional cost was incurred in placing the wires underground.

Atlantic Heights.—The installation at Portsmouth, N. H., while similar in many respects to the one just described, had these differences. The primary lines were kept off the streets

FIG. 41.—Plan of electrical distribution system of the Portsmouth, N. H. housing project of the Emergency Fleet Corporation.

entirely and located in easements in the rear of the houses, as alleys were not provided. The house services were extended from the poles in the rear instead of being carried on brackets, this being preferable, since many of the houses were of the semi-detached type.

Connections to the street lights were made by extending the overhead construction from the points where the lighting circuits crossed the streets, and sometimes by looping out from the pole

lines on the easements. Therefore, some poles and short runs of overhead construction are placed on the streets, but they are so few as to be relatively insignificant and do not detract from

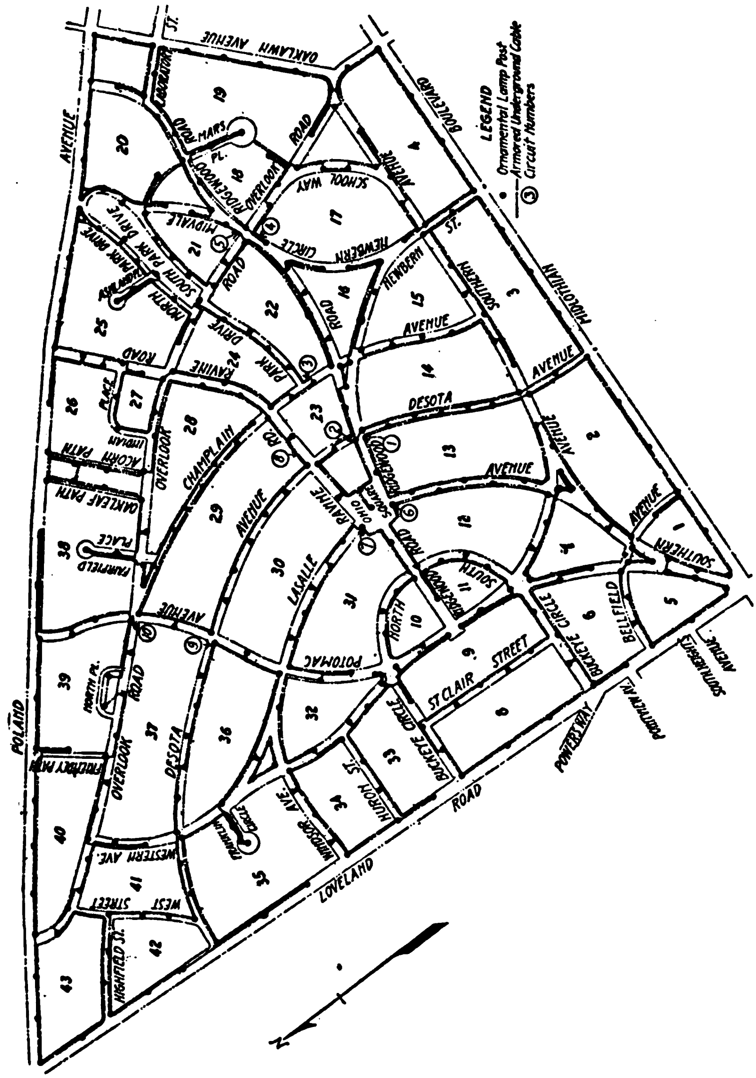

FIG. 42.—Plan of street lighting system[1] installed in the Loveland Farms housing development; underground construction.

the general satisfactory appearance. Street lights are of 100 candle power, of the series incandescent type, carried on brackets attached to wooden poles.

Underground construction was used for carrying the street lighting circuits of Kearsarge Street and Treble Way, so as to avoid affecting the appearance of this intersection, at which point there is a small park. The plan of the arrangement can be examined in the illustration shown in Fig. 41.

Loveland Farms.—The features of the installation made for a housing development for the skilled employees of an industrial corporation at Youngstown, Ohio, known as the Loveland Farms Development, are of interest, because of the attractiveness obtained without unduly adding to the cost. The primary and secondary house lighting circuits were carried entirely on pole lines, located in the easements in the rear of the houses, and there are no poles on the streets except where these lines make crossings.

The street lighting system is supplied by underground series circuits, ten in number, each feeding approximately 31 lamps spaced from 125 to 150 feet apart. The street lighting primary lines of 2300 volts, 3-phase, 60 cycle current were carried on the same poles which carried the house lighting circuits. The secondary street lighting circuits were of armored cable, laid without the use of conduit, in narrow trenches about 15 in. deep, located between the curb and the sidewalk. The arrangement of the street lighting circuit and light locations, is shown in Fig. 42.

CHAPTER X

HOUSES FOR FAMILIES

STANDARDS AND REQUIREMENTS—TYPES AND GROUPING OF HOUSES AND ACCESSORIES—BUILDING TECHNIQUE—DETERMINATION OF ACCOMMODATIONS REQUIRED

Introduction.—What is a Home? Adams, in "Housing Problems in America," answers "It is not a mere place of shelter in modern democracy. It must provide conditions that will promote efficiency in labor and strength of character in citizenship." Going further, he says "The home connotes the family; and the family and not the individual is the unit of the civil structure. A true housing policy must go further than improving or providing dwellings, it must be a part of a comprehensive policy of town and country development."

If these views are accepted—and they would seem to be above dispute—then we will realize how important is the problem of offering suggestions which may serve as a guide in the producing of better dwellings to serve as homes. What then is necessary to "provide conditions that will promote efficiency in labor and strength of character in citizenship"? Primarily, a house in which it will be possible for such conditions to exist as well as promote human welfare: this states the minimum requirements of an industrial worker's dwelling.

Various opinions concerning these minimum requirements have been expressed and, if nothing more came therefrom, they have at least served to stimulate thought upon the matter, by enlivening discussion on the part of deeply interested people. We propose in this chapter to consider some of them.

STANDARDS AND REQUIREMENTS

Basis for Standards.—Before attempting to list suggested standards, we must keep in mind certain basic factors which have a determining influence.

Permissible Rental.—In a housing development, built for rental purposes, the relation of the sum the wage earner can afford to pay, to the amount of the investment, offers a serious difficulty in arriving at minimum requirements. If standards are suggested that will fully realize ideals as to what the home should offer, the cost will be so high that even a modest profit on the money invested will place the rental beyond what the wage earners can afford to pay. Whereas, if the standard be determined by the rental within the reach of the working man, then the conveniences and accommodations offered will be below what should be considered adequate, and we will have failed to meet the problem. The conditions are equally puzzling in the development built for sales.

When the subject is looked squarely in the face, we find there are but two ways out of the difficulty; either (1) reduction in the cost of building to the workmen, or, (2) rise in income which will allow the man to pay more rent. Individual industries may solve their own problems by writing off enough of the investment to bring the relationship to a normal basis. This, however, does not dispose of the question as far as the masses are concerned. Assistance from governmental sources has been suggested, but has not been favorably received. Regardless of how solution may be affected, the standard must be such as to provide for the safety, health and comfort of the worker and his family.

Cost a Factor.—The housing planned by the Federal Government for war workers was, for the most part, designed to serve the skilled workmen rather than common labor; also, under the stress of war, cost was not so important an element as in pre- and post-war periods.

Housing for the skilled worker does not offer serious difficulties; it may be considered as fairly well solved in many instances. It is suitable housing for unskilled labor that is causing the greatest concern at the present time. The laborer's family on the average is as large and in many cases larger than that of the skilled worker. High cost of food, clothing, fuel and the necessities of life are the same for the former as the latter. Frequently, therefore, the difference in wage scale is reflected in the contrast of living conditions, which is unfortunate and profoundly affects the stability of our industrial life. How then can the essentials of decency and hygiene, not to speak of the so-called luxuries, be provided for the unskilled worker and

his family, to the point required, if contentment and happiness are to prevail? This is the great problem of Industrial Housing and in its solution lies in great measure the safety of our whole social structure. Chapter II discusses this problem in general. In this chapter the savings in house details and appurtenances which will promote the desired result will be considered.

Other Influences on Standards.—Building codes, housing laws and similar restricting ordinances, where existent, will and do affect standard requirements. Where unduly onerous—and in some cases this is true—attempt may well be made to modify some unnecessary features thereof. In addition, there are purely fabricative considerations. For instance, the house must be a sound shelter from the elements; it must be substantial and subject to as little deterioration as possible; it must afford a proper amount of light and ventilation, and must contain necessary equipment for lighting and heating and sanitation.

Standards from Experience.—As a means of determining what the workers really want, one large concern circulated questionnaires throughout three of its developments representing a total of five hundred houses. These included a number of items for the purpose of developing what the people desired in general plan, arrangement, number of rooms, character of rooms, and extent of convenience required. The interviewer also observed what furniture the average tenant owned, and received what suggestions the people had to offer which, to their minds, would make the houses more satisfactory. From a study of these questionnaires the following points have been noted:

First.—The average size house desired is between 5 and 6 rooms.

Second.—Small kitchens or kitchenettes are objectionable. Kitchens large enough for general dining purposes are preferred. Even the tenants of better grade houses, in which separate dining rooms were provided, dined a portion of the time in the kitchen. In the few houses where provided, combined dining and living rooms were held in disfavor; in many of these cases, the people managed to use some other room for dining, although such space was manifestly too small, and resulted in serious crowding.

Third.—Built-in features, such as buffet, china-closets and bookcases, are not generally desired, except in the higher grade houses, because most tenants have furniture which serves the same purpose; and such attached facilities result in a lack of space for furniture. The addition of these, moreover,' is to be discouraged upon the standpoint of cost. While aware that arguments have been advanced in favor of these built-

in features, on the basis that they permit a saving on the part of tenant by relieving him of the necessity of the purchase of furniture, the reasons for their omission are of great weight.

Fourth.—Objections are raised to single bedrooms; many people using double beds only. When only two bedrooms are provided, they should be double rooms; when three or more are used, it is rarely safe to plan more than one single room, except in houses of eight or nine rooms and houses designed for lodgers.

Fifth.—Objection is raised to having the refrigerator in the basement; a space convenient to, but not in the kitchen, being requested.

Sixth.—A grade entrance to a landing on the stairs, running from the first floor to basement, is favorably commented upon. Refrigerator space may be arranged off this landing as an added convenience.

Seventh.—If the cellar contains a furnace, it has been found that, in order to keep fruit and vegetables, a space should be partitioned off for this purpose. This compartment should have no window, but should have outside ventilation by running a 2-in. gas pipe through the wall and placing a wire netting on the inside, to prevent insects and mice from entering. Where porch foundations are constructed of masonry walls, this space forms an admirable fruit closet. This, however, entails additional expense, as the porch foundation must be run down to full cellar depth, instead of just below frost line, and a doorway provided into the cellar.

Number of Rooms.—One of the first questions to arise in designing houses for a development is, what number of rooms shall the house contain? To follow the practice established by some other development may result in unsatisfactory conditions. Difference in character of labor employed, and in conjugal relationship, demands an analysis for each development, and best results will be attained by studying the social structure of each. Great benefit will be derived from a knowledge of the manner in which these problems have been attacked elsewhere and of the line of reasoning which has produced satisfactory results. But a careful discrimination must be made between appropriating the processes of reasoning and accepting the results of that process.

Data relating to the character of labor employed and the conjugal relationship existing in the separate families is necessary. This is easily obtained in an industry fully organized. In the case of a proposed industry, however, information regarding the personnel of the working forces must be forecasted by comparison with similar industries. With such information, it will not be difficult to choose the types and grades which best serve the particular case under consideration.

Furniture Requirements.—To intelligently recommend minimum room sizes, it will be necessary to know what they are to contain in the way of furniture. To that end the following list and size of furniture is offered:

Living Room

Piano: 5′–6″ × 2′–4″ × 4′–8″
Table: 2′–0″ × 3′–6″
Three Chairs: 20″ × 18″ or
One Chair and Davenport: 6′–0″ × 2′–4″

Dining Room

Table: 54″ diameter
Buffet: 5′–0″ × 1′–10″
Six Chairs: 16″ × 18″

Bed Room (Double)

Double Bed: 4′–6″ × 6′–6″
Dresser: 3′–6″ × 2′–0″
Other Piece: 3′–0″ × 1′–10″
Two Chairs: 16″ × 18″

Single Bed Room

Single Bed: 3′–0″ × 6′–6″
Dresser: 3′–6″ × 2′–0″
Other Piece: 3′–0″ × 1′–10″
One Chair: 16″ × 18″

In addition to giving space for the above listed furniture, the wall space will be interrupted by windows, doors and hot air registers.

Minimum Room Sizes.—In the living room, dining room and bedroom, the following minimum sizes have been prompted by a careful study of a large number of satisfactory plans.

A living room should be at least 12 ft. by 14 ft. exclusive of any encroachments, such as closet space or portion of stairway issuing from living room.

A dining room should contain not less than 120 sq. ft., with 10 ft. the least possible dimension.

A double bed room should contain not less than 120 sq. ft., the smallest dimension being not less than 9 feet 6 inches.

A single bed room should not be less than 80 sq. ft., the smallest dimension being not less than 7 ft. 10 inches.

The bath room should not be less than 35 sq. ft., with a minimum width of 5 feet. In such a room, the fixtures would be placed along the wall the long way of the room. The tub, which should measure 2 ft. 6 in. by 4 ft. 6 in., would take 2 ft. 6 in. space, plus 1 in. for clearance, or 2 ft. 7 in.; the wash stand, measuring 18 in. by 21 in., would require 2 ft. 0 in. wall space, and the toilet, measuring 20¼ in., width of low down tank, would require 2 ft. 0 in. wall space; or a total length of 6 ft. 7 in., necessary wall space to house fixtures. This permits 5 ft. margin to work in, which allows for irregularities in roughing-in of plumbing or general construction.

The kitchen area depends on several factors. From a survey

of eighteen house plans, in which a separate dining room was provided, it was developed that, in an average size house, about seventeen per cent. of the entire first floor area was used for the kitchen. Assuming a house 24 ft. square, or 576 sq. ft. in area, the allowable space for kitchen would be approximately 98 sq. ft. Being guided by a further stipulation that the room shall be not less than 7 ft. in width, the greatest possible perimeter is 42 feet.

The requirements to be met in a kitchen are: (*a*) a door to rear porch; (*b*) a door to dining room; (*c*) a door to cellar; (*d*) at least one window (preferably in a wall other than the wall with outside door); (*e*) a kitchen case which, when no other cupboard or pantry is provided, should measure 5 ft. in length; (*f*) a standard sink and drip board, measuring 5 ft. in length; (*g*) space for stove which, when placed in corner of room, requires 6 ft. of wall space. These various items require a total of 30 ft. of wall space in a room with 42 feet. The 12 ft. remaining is divided into small spaces between the various items listed.

However, by careful designing, it is often possible to reserve enough of this space for a table, 2 ft. by 3 ft. It will be seen that in a kitchen, using the minimum width of 7 ft., it will be difficult to place the table so as to sit around its four sides.

From these observations it will be apparent that the greatest care is required to design the small kitchen, and that the use of this kitchen for dining is almost impossible.

Having arrived at the minimum sizes of first floor rooms necessary to accommodate average furniture, similar detailed studies may be made for the second floor. A summary of such tests has been made after a review of the tables giving data on family dwellings, prepared by the United States Housing Corporation, and also by a careful study of its standard plans. The area of all bedrooms and bath, excluding closets, trunk rooms, storage spaces and stair halls, should be 72½ per cent. of the total area of the second floor, measurements in all cases being to inside finished walls. Should a plan fall slightly below this percentage, it need not necessarily be rejected, and some plans may be found to give higher percentages; but, striking an average, the plans should realize the percentage given.

Recommendations of Authorities.—Various views have been expressed as to what should constitute minimum requirements for a satisfactory house. That there should be a difference of opinion among those who have made a study of the problem

is easily understood when we realize the divergent characteristics of humanity. Furthermore, the variations represent unquestionably views as to different classes of dwellings desired. Some of these are abstracted in the following paragraphs.

Veiller's Views.—Houses for skilled workers at Williamsport, Pa., Sawyer Park, recommended by Mr. Lawrence Veiller, Secretary, National Housing Association, contain the following features:

Every house has a well lighted and ventilated cellar, with concrete floor and a hot air furnace, with pipes to each room on the first and second floors. Bathroom has a porcelain tub, wash bowl and toilet fixtures. Kitchen has a sink and porcelain wash tub. Every house has front porch and an entrance to kitchen. Houses are piped for gas and wired for electricity; clothes closets are provided. In addition to the above, a kitchen cabinet and a linen closet are recommended for each house.

Groben's Recommendations.—The opinions of William E. Groben, of Ballinger and Perrot, Architects, of Philadelphia, Pa., are as follows:

Essentials for unskilled, low paid workmen's houses are permanent water-tight construction of walls and roof; sufficient sunlight and ventilation, and windows in every room. Private toilet, with sanitary water closet, having sewer connection; sink in kitchen, with running water and sewer connection, are necessary. Gas or electric light and proper heating apparatus are required. Combination living room, dining room and kitchen; bedroom, large enough for parents with infant children; bedroom for male children; bedroom for female children, are the minimum requirements.

Essentials for skilled, high-paid workmen's houses contain the above, plus cast iron enameled bathtub, with running water and waste; wash bowl in bathroom with tub and toilet, with hot water supply; and a living room separate from dining room and kitchen.

Accessories called for as essentials by some skilled, higher-paid American workmen consist of cellar, laundry tubs, front porch, wallpaper and tiled bathroom.

Allen's Ideas.—The recommendations of Leslie M. Allen, of the Aberthaw Construction Company, contain the following as housing essentials:

Water-tight roof, walls and floors; separate bedroom for parents; separate bedroom for male children and for female children; living room for cooking, eating and general day use; uninterrupted daylight and

ventilation through windows in every room; suitable heating arrangements; private toilet room, with sanitary water closet and sewer connection; sink in kitchen with running water fit for drinking, and waste.

Further additions required by the American family are cellars, closets, bathtubs with running water, window screens and separate parlor.

Desirable improvements include porch and veranda; lavatory bowl; hot water, supplied to bathtub and bowl; window shades and window blinds; separate dining room; electric or gas lighting; wall paper; and laundry tubs.

Kilham's Opinions.—The views of Walter H. Kilham, of Kilham & Hopkins, Architects of Boston, are:

The question then arises as to what constitutes fundamentals. I should say light and air, hot and cold water; facilities for bathtubs, even at the expense of leaving out a wash bowl. Refrigerator space; and as many bedrooms as possible. I should not so class furnaces, piazzas, fireplaces, parlors separate from the kitchen, nor set wash bowls. I am not so sure of the necessity of set washtubs in these days of wet wash laundries. Kitchens must have accommodations for simple stock of groceries, either in pantry or in a cabinet of some sort.

U. S. Dept. Labor Standards.—The following were promulgated by a committee of architects and civicists:

Row or group houses normally not to be more than two rooms deep; no living quarters in basement; every bedroom to have a clothes closet; every room to have at least one window opening directly to the exterior; minimum height of room, 8 ft.; minimum areas;—bedrooms, 80 sq. ft.; parlor, 120 sq. ft.; dining room, 108 sq. ft.; kitchenette, 70 sq. ft.; where there is no dining room, kitchen should be 108 sq. ft. A toilet and bath for each house or apartment.

Albany Health Dept. Regulations.—The following are quoted from the published ordinances of this City:

Each room must have at least one window with area of 12 sq. ft.; no room shall be less than 90 sq. ft. in floor area, nor less than 7 ft. wide; no ceiling in dwellings shall be lower than 8 ft. 6 in.; each toilet room requires 6 sq. ft. of window space opening to outside; each dwelling shall have one sink with running water.

Ontario Housing Committee Objects.—The following is quoted from the report of this citizens' committee, issued in 1918:

There must be some definite classifications taken as a basis in formulating standards. Careful investigation of living conditions has estab-

lished certain requirements as essential, and others as desirable. There will undoubtedly be some criticism of any attempt to classify essentials, and there is bound to be diversity of opinion, but for our purpose the essential features may be summarized as follows:

1. Sufficient land to give each family privacy and plenty of air.
2. Water-tight floors, walls and roof.
3. One or more rooms for cooking, eating and general use.
4. Bedroom for parents' use.
5. Bedroom for male children.
6. Bedroom for female children.
7. Provisions for toilet, with sanitary water closet and sewer connections.
8. Running water supply fit for drinking.
9. Kitchen sink, with waste connection to sewer.
10. Uninterrupted daylight and ventilation, for windows in every room.

Additional features which are so desirable as to be almost essential are:

1. Bathtub and lavatory, with hot and cold water supply.
2. Laundry tubs, with hot and cold water supply.
3. Direct sunlight in all rooms.
4. Second room in addition to that used for cooking.
5. Clothes closet.
6. Porches and verandas.

Future additions of desirable features would include:

1. Electric lights.
2. Separate dining room.
3. Cellar.
4. Furnace for heating.

Some comment may arise on the omission of cellar from the list of essentials. There are those who claim that the cellar is essential for the storage of fuel, canned fruit, vegetables, etc., and that, since foundation walls are necessary, it costs no more to provide a cellar than to omit it. This latter question will be considered along with the following items entering into the house construction. Regarding the storage of fuel, etc., a careful survey of conditions will disclose the fact that with many families the income will not provide sufficient surplus to permit the purchase of fuel, vegetables or fruit in sufficiently large quantities to require a cellar for storage. On the other hand, where cellars are provided, they will frequently be found to contain a miscellaneous assortment of unsanitary rubbish, which constitutes a serious fire menace.

Data of U. S. Bureau of Labor Statistics.—As indicative of the kind of houses most generally employed in industrial developments, the data of the United States Bureau of Labor Statistics

may prove both instructive and interesting. An investigation covering two hundred and thirteen separate companies, including subsidiary companies of large corporations, showed the number of men employed was 466,991, of whom 160,645, or 34 per cent., were accommodated in houses controlled by the companies. Of the 53,176 individual dwellings considered, it appears that 25,582, or 48 per cent., were single dwellings, 18,871, or 36 per cent., double dwellings, and 6,014, or 11 per cent., row dwellings.

It is interesting to note in passing that, in the early stages of industrial housing, as, for instance, in the urban New England mill tenements, the row type prevailed, with the double dwelling next most common. The proportion of the row type shows a steady decline as industrial housing has developed, although now there is a growing appreciation of the group dwelling and to some extent of the row type of dwellings.

As regards the number of rooms, it was found, in the aforementioned investigation that 15,672 houses, or 30 per cent., had four rooms; 9,413, or approximately 17 per cent., had five rooms; and 9,127, or approximately the same percentage, had six rooms. It is apparent that the typical dwellings contained four, five or six rooms. It does not follow that these proportions are for general application. Quite to the contrary; as we know industrial housing today, it presents a far different problem than the earlier examples indicate; nevertheless, these statistics record the general history of the movement and are of benefit in searching for the next step.

As regards the general construction of the houses, the frame structure was found to be the most prevalent; brick used about one-tenth as much; other materials less prevalent than brick.

Recommended Minimum Requirements.—From information obtained by a study of the intimate family life in various industrial towns, after consideration of the many practical elements entering into the question, and taking into consideration the expressed opinion of many qualified authorities, the author's recommendations as to the minimum requirements of "An Industrial Worker's Home" are as follows:

1. *Materials.*—Permanent weather proof construction of exterior walls and roof.

2. *Cellar.*—Cellar to be provided, except in localities where impractical or unnecessary.

3. In case cellar is omitted, first floor to be at least 2 ft. above

ground and supported on masonry piers or foundations carried below frost line; and the clear space enclosed but adequately ventilated.

4. Where cellar is provided, it shall have cement floor and floor drain.

5. Cellar to be properly lighted and ventilated.

6. No living quarters to be in basement.

7. A separate chimney flue to be run to the cellar for future installation of a furnace.

8. Adequate provision must be made for heating the house, but furnace should not be minimum requirement. All heating fixtures, whether using gas or other fuel, must be provided with vents to flues.

9. Gas piping to be provided for kitchen range and hot water boiler.

10. *Rooms.*—One room for parents and infant child and enough rooms for other children for proper segregation of the sexes.

11. Room sizes to accommodate minimum furniture as listed. The furniture to be drawn in to scale on plans, so as not to conflict with windows, doors or hot air registers.

12. Row or group houses to be not more than two rooms deep; except in rows where combinations of units (as one 4-room, two 6-room, and one 4-room) allow for proper ventilation to the rooms of the deeper unit by the nature of their arrangement.

13. *Duplexes, Double Duplexes, etc.*—In all such units, provision shall be made for obtaining as great a degree of privacy as is enjoyed at least in the row type house. Separate front and rear entrances, separate cellars when cellars exist, with independent plumbing lines, and heating and lighting facilities. It is also recommended that means of circulation between each apartment and private cellar be effected without going outside the house.

14. *Closets.*—Every bedroom must have clothes closet in direct connection with it.

15. Closet or case of adequate size for keeping necessary china, kitchen utensils, staple supplies, etc., must be arranged for in kitchen.

16. *Entrances.*—There must be means of entrance other than by the front door.

17. Front porches, while desirable, are not a minimum requirement.

18. In no case should the stairs have a rise of over 8 inches and tread of less than 9 inches.

19. *Ventilation.*—There shall be a clear height of not less than 6 ft. 6 in. from cellar floor to under side of first floor joist. A minimum clear story height of 8 ft. shall generally obtain for first and second stories, but in cases of second story rooms coming under sloping roofs, it shall be required that flat portions of ceiling be over an area of at least 40 sq. ft. with 3½ ft. minimum flat ceiling width and a clear height of 6 ft. over an area of at least 80 sq. ft. with a minimum width of 7 feet. (Attic rooms not subject to these requirements.)

20. There shall be in all cases an air space, with minimum of 8 in. from

ceiling to roof, with provision that such space be ventilated directly to outside air.

21. Every bedroom to have at least one window opening directly to outer air.

22. One window to be sufficient for single rooms, two windows for double rooms. No room to have less than 12 sq. ft. of window area.

23. Bathroom to have one window of not less than 6 sq. ft. area.

24. Water closet compartment to have one window of not less than 4½ sq. ft. opening directly to outer air.

25. Skylight may be used in lieu of window for bathroom or water closet compartment.

26. Window frames to be of such design that screens may be used.

27. *Water Supply.*—Running water to be required in connection with kitchen plumbing fixtures. (Hot water connection is desirable.)

28. A water closet in separate compartment, properly ventilated, must be provided when bathroom is omitted.

29. While bathroom is greatly to be desired, it is not to be a minimum requirement; provided convenient and complete bath house facilities are arranged for and properly maintained for community use.

30. Either laundry trays to be provided in cellar or combination tray and kitchen sink in kitchen.

31. Electricity to be furnished whenever possible. One switch to be provided for throwing on light on entering house and one switch to control cellar light from top of cellar stairs.

Grading of Houses.—There is included in the minimum requirements such provisions as will make possible a house in which any person can live comfortably and decently. A house built under these conditions will not contain many of the features which, while not absolutely necessary, are desired by many workmen's families.

If the term "Industrial Housing" applied only to the lowest paid unskilled workers, it would be unnecessary to consider any but essential features; however, a large percentage of wage earners are skilled workmen, who, imbued with higher standards of living, not only desire but demand additional features in the house. They are able and willing to pay for such conveniences. It, therefore, seems necessary to arrive at some classification of houses suitable to the corresponding grades of workmen which exist in the personnel of industry.

Many persons have deemed two classifications all that are necessary,—one for unskilled workers, and one for skilled workers. This differentiation, however, is considered to be too abrupt and

not furnishing sufficient gradation, by men intimately acquainted with the wage earner and his family life. The native unskilled worker must often be provided with a better house than the rank and file of unskilled wage earners, and yet he cannot pay for the houses provided for higher paid skilled workers. On the other hand, if he does not have children, he probably is in a better position to afford these accommodations than the skilled worker with a very large family, who certainly will never be satisfied to drop down to the grade of house provided for unskilled laborers.

It is believed, therefore, there is considerable advantage, if not absolute necessity, in providing three grades of houses, as

FIG. 43.—A view in Yorkship Village illustrating attractive and interesting effect secured in intersection planning and house grouping.

follows: *First,* A house as inexpensive as it is possible to build and still meet the demands of a home for unskilled labor; *Second,* an intermediate grade, to meet the demands mentioned in the previous paragraph; and *Third,* a more expensive grade, for higher wage earning skilled laborers, shop foremen, or the higher paid men of the clerical staff.

For convenience, the three grades will be referred to respectively as Grade C, Grade B, and Grade A.

Grade C—House shall have the minimum requirements, as before stated.

Grade B—House shall have all the features of a Grade C house, with the following additional conveniences:

1. Room for dining, separate from kitchen.
2. Bathroom shall constitute a minimum requirement; in which shall be provided the following fixtures: Enameled roll rim bathtub, 4 ft. 6 in. by 2 ft. 6 in.; lavatory, 18 in. by 21 in.; water closet, porcelain and wash down, syphonic action; enameled low down tank.
3. Rift sawed yellow pine floors in first floor, plain sawed pine in second floor.
4. Provision for refrigerator space adjacent to, but not in kitchen, which may be built in compartment on rear porch.
5. Front porch, not less than 70 square feet.
6. Lighting fixtures in rooms, except bracket in bathroom, to be controlled by switches located conveniently at entrance doors.
7. Hot air furnaces; cold air returns to be taken from inside.
8. Laundry trays in basement.
9. Mechanical door bells.
10. Coal bins.

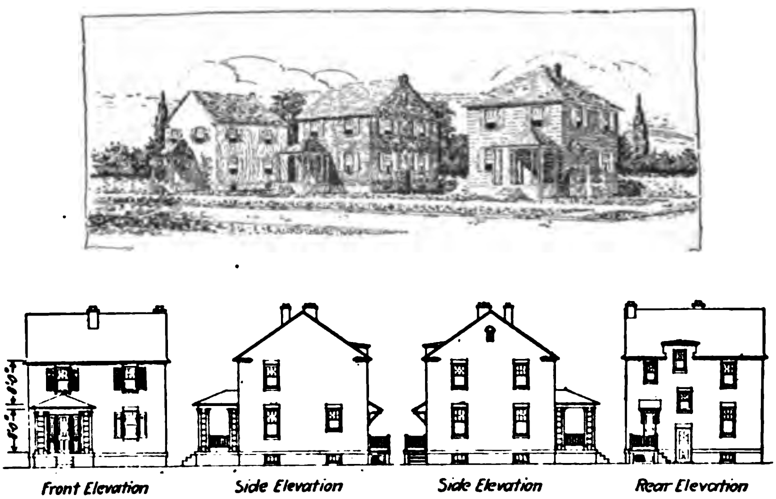

FIG. 44A.—Design of a six-room detached dwelling, showing the possibilities in variation of exterior appearance of a single base type; variation obtained by changing the roof design, using different exterior materials and placing the porch in different positions.

Grade A.—House shall contain all the features listed for Grade C and Grade B houses, with the following additional accommodations: Such a dwelling is illustrated in Figs. 44A and 44B.

1. The rooms to be larger than the previous minimum requirements.

Single bedroom	90 sq. ft.
Double bedroom	130 sq. ft.
Dining room	140 sq. ft.
Living room	180 sq. ft.

2. A coat closet shall be provided, either off hall in first floor or in connection with living room.

3. Open fireplace, with basket grate in living room.

4. Rift sawed yellow pine or oak floors in first and second floors.

5. Front porch with minimum of 96 square feet. Rear porch.

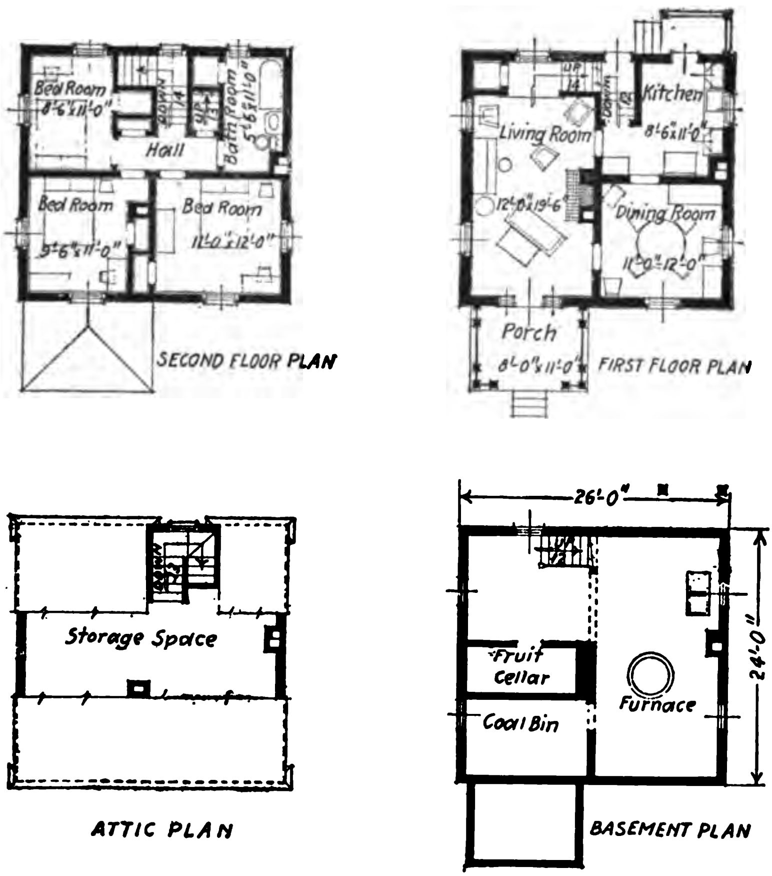

FIG. 44B.—Floor plans of six-room detached dwelling. (See Fig. 44A.)

6. Two-way switches, for controlling one light upstairs and one downstairs.

7. Medicine cabinet in bathroom.

8. Combination gas and electric fixtures for lighting in kitchen and bathroom.

With the exception of combined uses for same room, the grading classification of the houses is not based upon number of

rooms. Grade C house, for example, might contain more bed rooms than Grade A house.

TYPES AND GROUPING OF HOUSES AND ACCESSORIES

Types of Houses.—Omitting for the present the consideration of materials used in construction, the cost of a house is primarily dependent upon the number of rooms it contains. By applying a sliding scale unit price per room, so adjusted as to cover the various grades of houses, we may arrive at a reasonable estimate of the cost per house; it being understood that number of rooms has no influence in determination of grades.

Effect on Cost.—Next to material and number of rooms, the types of building employed—that is, whether single houses, double houses, groups, rows, etc.—have an important bearing on the cost. This is true not only of the house itself but the entire project, as the land cost is directly affected in consequence of the type employed.

The words "grade" and "type" are used with careful distinction—houses are "*graded*" according to the facilities furnished and largely in relation to the cost, whereas "*type*" refers to class of building or arrangement of houses.

The following house types will be considered, as experience indicates that they are the most practical and satisfactory:

Type I. Single detached house.
Type II. Semi-detached house.
Type III. Row or group house.
Type IV. Single duplex house.
Type V. Double duplex house.
Type VI. Row duplex house.
Type VII. Apartment house.

Explanation of Types.—*Type I.—Single detached house* is a house occupied by one family only. All four sides of the house are exposed, the unit standing independently on its own lot, with grounds bordering it sufficiently large to allow for light and air. See Fig. 44A for illustrative example.

Type II.—Semi-detached house is one in which two separate and distinct dwellings are arranged side by side under a common roof. The dwellings are completely separated by a party wall and each dwelling has three exposed sides. Fig. 45 shows such a house with eight rooms in each unit, for the higher paid men.

Type III.—Row or group house is a unit of three or more (rarely over eight) separate dwellings, arranged side by side under a common roof and separated by party walls. The houses should not be over two rooms deep, except when arranged in such combinations that will allow light and air to the deeper dwellings by reason of the design of the group. These dwellings should have rear access from a street, alley or common court, or passage from the front to the rear or cellar: See Figs. 47 and 48.

Type IV.—Single duplex house is one providing two separate dwellings one above the other. Each must have separate entrances, front and rear. Each dwelling to have its own private

Fig. 45.—Semi-detached eight-room dwellings, Yorkship Village project, Emergency Fleet Corporation.

cellar, reached without going outside the building. Each dwelling has four exposed sides.

Type V.—Double duplex house, as the name implies, is formed by arranging two single duplex units side by side, so as to form a unit under one roof, in which four families are housed. The general provisions called for under the single duplex apply with equal force in this case. Each dwelling has three exposed sides. Fig. 46 shows such a house.

Type VI.—Row duplex is obtained by arranging three or more single duplexes side by side. It must be only two rooms deep except at end houses.

Type VII.—Apartment house can be arranged for any number of apartments, composed by varying numbers of rooms. This

type differs from the other multiple family houses in that the apartments are reached through a common entrance and stairway. By its very nature this style necessitates joint use of cellars, laundry facilities, etc., by all the tenants; whereas the duplex dwellings enjoy privacy in this respect. The heating must be from a central plant. This fact, as well as the others enumerated, make it necessary to provide janitor service, which complicates the problem from the standpoint of the investor.

Many arguments may be advanced for and against the employment of the various types. The detached house meets with general approval from native American workmen, because it typifies

FIG. 46.—View of four-family duplex dwelling.

the traditional tendencies of selective American housing, which have come down to us from pioneer days. However, memory of the early homes of our forefathers, with their privacy and homey atmosphere suggesting independence and sole proprietorship, should not be allowed to befog the conditions as they exist today. The motives which impelled the building of these early homes, as well as the natural conditions surrounding them, are just as different from present day building as the manner of living was different from that of the present.

The detached house offers the possibility of cross ventilation of rooms and greater amount of sunlight, but when the houses

are placed close to one another, because of high land values, it is a question whether these features, instead of being advantages, are not the opposite. The narrow side yards, devoid of the possibility of air and sunlight, offer little that is to be desired, either in making for a dignified setting for the house, or as a means of obtaining the advantage of exposure for the various rooms. These side yards often degenerate into damp, dark alleyways, in which it is impossible to cultivate plant life. If such is the case, how can we hope for good results from them as light and air shafts?

As to the question of privacy in this type, as contrasted with the multiple unit or groups, providing sound-proof party walls are used in the latter, there is probably less privacy, since in the group it is at least impossible to look directly from one house into another. The detached home is a more costly investment, not only as to first cost, but also as regards maintenance. A greater number of exposed sides is subject to deterioration; it is more expensive to paint, and to heat. Gas bills for the end houses of rows are frequently one and one-half times those of the interior houses. The housewife prefers the multiple type, as there are less windows and curtains to keep clean and less expense in furnishing window trimmings.

From the standpoint of exterior architectural appearance, it must be added, the small detached house offers one of the most difficult problems the designer has to meet. No matter what the area of the house may be, the height remains fairly constant for all types. The result, in the case of a single house of small area, is that, having to meet the requirement for height, it is extremely difficult to arrive at a proportion that will not look stilted. The architect, in his desire to arrive at better proportions, strives to pull down the apparent height by dropping the eaves to a degree that necessitates sloping ceilings, and knee walls. This, however, often results in serious inconvenience in the livableness of the bedrooms. It has been noted that in some single house developments such designing necessitates placing the bed a foot to 18 in. from the wall, in order to obtain sufficient height to accommodate the headboard. This, in admittedly small rooms to start with, is a serious inconvenience.

In the multiple unit, the architect finds a much simpler problem in trying to obtain architectural effects. Not only is it possible to obtain better general proportions, but the many

possibilities in grouping of various sized units, together with the variation permitted in arranging porches and composing of roof lines, give a latitude in designing which makes possible compositions abundant in picturesqueness and charm.

A consideration which must not be overlooked in a study of the types is the nature of the investment, whether it be for rental or sale, viz.: The objection to buying or selling individual dwellings in a multiple unit, group or row, is not to be overcome by edict, but the fact that in certain localities such transactions are common practice leads one to believe that, should the present high cost of building prevail for an extended period, the prejudice

FIG. 47.—Typical row dwellings, Yorkship Village.

against owning such a home may be overcome by force of circumstance. In view of this fact, it is suggested that, should multiple units be constructed with the idea of selling the individual dwellings, the designer should strive to make the houses as independent as possible. In this connection, the unit should differ from the renting project, in that plumbing lines for each house should be run separately; porches should not overlap the adjacent dwelling; separate entrance pathways must be provided, and, even in units under a common sloping roof, party walls should be run through the roof. This last provision, although it may sound a serious disadvantage, will be found on careful

study to offer great possibilities in the way of an interesting decorative treatment. As an example illustrating this point, see Fig. 48.

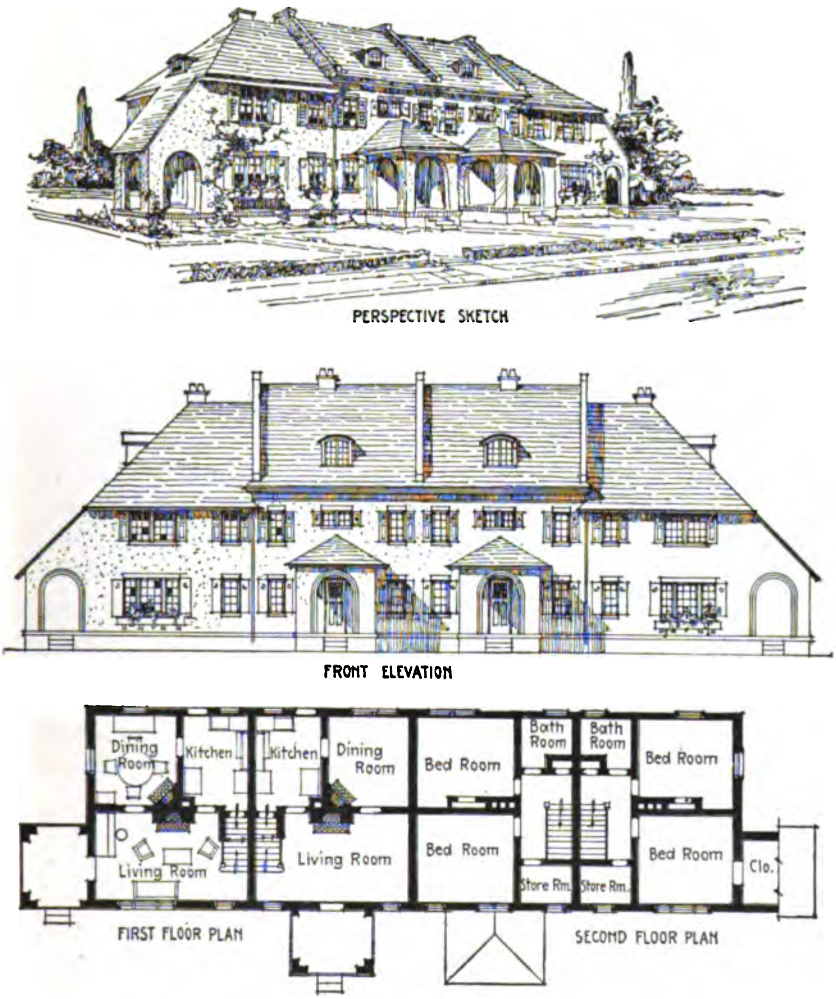

Fig. 48.—Multiple family dwellings illustrating possibilities of treatment where division walls are carried through and above the roof.

The duplex and apartment types are essentially those built on the policy of rental, but they meet some demands better than any other type. It will be manifest that a dwelling of three rooms and bath, in any of the single family units, is practically an

impossibility. Yet accommodations of this kind are in great demand by young married people without children, who in starting housekeeping cannot afford to furnish larger quarters, for which, indeed, they have no absolute need. If such people be obliged to take a larger house, then they must rent a room or two to lodgers, which creates unnatural and often unpleasant conditions in the home life and leads to dissatisfaction.

Finally, to sum up in a few terse sentences recommendations based upon the foregoing arguments, it is suggested:

First.—That the detached house be employed for Grade A dwellings, in either a sales or renting project.

Second.—That the semi-detached unit be employed principally for a Grade B dwelling, but under some circumstances, especially when land values are high, for Grade A dwellings. This type should be used for the most part in a renting project, but, when designed with care to offset prejudices relative to joint ownership, it may be built for sale.

Third.—The row or group type should be particularly identified as a Grade C dwelling, although it will be found entirely satisfactory for the Grade B, when it incorporates the necessary features to identify it in that class. However, it should rarely, if ever, be used for A-houses, not because it is an unsatisfactory house for any class of people to live in, but merely because prejudice is still so strong against the idea of living in a row. Eventually this feeling, we are sure, will be overcome and the row type house, properly designed, will come into its own. This is quite easily appreciated when one stops to think that many of the older city residences of the well-to-do in some cities are virtually row type dwellings.

The duplex and apartment types may readily fit any of the grade classifications and, of course, apply only to renting developments.

Grouping of Types.—The composition of house units to form a block should be guided by the following fundamental considerations:

1. The houses adjacent to one another, if they are detached units, should be of types which will permit of as great privacy as possible. This is accomplished by arranging that the windows of one do not come directly opposite those of another and, if possible, so that the stair side faces the living quarters of the opposite house.

2. House plans should be arranged so as to have as little conflict as possible in location of porches and also to guard against the rear service of one house being in full view of the front porch of the next unit.

3. Monotony should be avoided by the employment of types, and by exterior variations of the same plans, to assure a pleasing contrast, especially in the composition of roof lines. This may also be done by reversing the plan of the same type occasionally. Variation by merely painting in different colors is of doubtful value, because by thus calling attention to the elements of the design, the similarity is, if anything, more quickly noted, and

Fig. 49.—Group of four-family apartment houses arranged about a court; Buckman Village.

because usually some one color scheme is productive of the best results, and the houses treated otherwise suffer in consequence.

4. There should be a feeling of unity in the general composition, and in the arrangement of the individual blocks. By this it is not meant that the houses of a given block must all be painted exactly alike or be exactly similar in the exterior details, but they should look as though they all belonged to the same general group. The placing of a one story house next a two and a half story house, or the placing of a flat-roofed row type next to one with sloping roof should be condemned. These, although extreme cases, serve to illustrate by exaggeration. Fig. 49 is illustrative of good grouping.

Where to draw the line between monotony and restlessness, caused by striving too hard for variation, is a delicate task; labored variety produces an unpleasant effect. Similarity of shape and contour must not be confounded with sameness of architectural style; and nothing is more pleasing than a development in which a general uniformity of exterior material and architectural style has been observed, and in which variation is obtained by ingenuity in the composition of the individual house, its relation to its neighbors and the delicate contrast of minor architectural details.

FIG. 50.—A row garage and service open space, Sun Hill project of the Emergency Fleet Corporation; an alternative to constructing the individual rear lot garage.

The Garage.—The automobile, whether it be called a luxury or a convenience, is becoming more and more a part of the general family equipment. Low priced cars have been developed to a point where it is just as possible for the working man to have one, as far as first cost is concerned, as to own a piano. The fact is that many do own automobiles. Some means of housing them is as necessary as shelter for other belongings.

Single Garage.—Only in the case of the more expensive grade of house should the single garage be provided; First, because very often these houses are of the detached type, which allows sufficient room for the garage without undue crowding of

the yard space; Second, because the man living in such a house can better afford to pay the increased rental on the property; and third, because it is fairly safe to say that any tenant occupying the house will possess an automobile.

Row Garage.—Garage accommodations for Grade B and for some Grade C houses should be effected by building a battery of garages at a selected place, convenient to the houses. The battery type is economical in construction and in use of land, and both result in appreciably lower rental.

In this class the possibility of every man owning a machine is much more remote than in the Grade A class, and to place a garage on every lot would result in some lying idle and the rear yards would be occupied with these buildings, which would yield no return. Further than this, the strictest control would not overcome the tendency to use these idle garages for the general accumulation of refuse. The battery garage is susceptible to the same line of reasoning as applied to the multiple dwelling and is consequently the logical type to use in such cases. Such a row is shown in Fig. 50.

Garage Construction.—Garages should be large enough to accommodate an average sized car, with space for a work-bench and shelves for supplies and tools. The side walls need not have any windows, as enough light will be afforded by providing glass in the double entrance doors and a double window in the rear wall. The latter should be placed high enough to allow the workbench to be placed under it.

Regardless of the material used for the walls, the foundations should be of masonry and extend below frost line. A satisfactory floor is constructed of concrete, and should pitch toward the entrance. Running water in the garage and electric lighting are desirable.

In some localities, ordinances require the garage to be of fireproof construction; concrete, brick and hollow tile walls are suitable for this purpose. When cost is not prohibitive, the single garage should reflect the character of the house it serves. When constructed in batteries, garages should be in harmony with the multiple dwellings of the neighborhood.

BUILDING TECHNIQUE

A discussion of the building technique must have as its keynote—lowest possible cost consistent with permanency of construction.

General.—Standardization of materials and millwork and quantity production loom large as two important aids in forcing down the cost of building. In all avenues of business it is cheaper to buy wholesale than retail, and the construction of houses is no exception to this rule. The term "quantity production", as used here, is not intended to mean greatness as relating to number of houses, so much as is meant large scale production and manufacture of materials of construction to be employed in the building of the houses. To buy advantageously in the greatest possible quantities necessitates buying the least possible number of different things, which leads directly to standardization of materials and units of mill work.

This theory has long been expounded in an endeavor to bring down building cost for the individual home builder and has resulted in the commercial specialization by what is known as the ready-cut or knock-down houses. The fact that such standardized complete houses are already developed and offer a wide and varied choice has led to the suggestion of their use in solving the Industrial Housing problem. Reasonable as this may sound, it must be evident that if care is exerted in designing for a situation, so as to use in all cases not only stock sizes of lumber but also stock mouldings, frames and various items of millwork, *i.e.*, stock products everywhere, the same economical results will be obtained, and the additional benefit of being able to secure the best solution for each problem, rather than to choose from a catalogue the nearest article, which may be far from satisfactory. Site conditions frequently require much ingenuity to make the dwellings fit the property. When such ready-cut houses serve a useful purpose in a hurry-up job, individuality, not to speak of greater architectural merit, will result, if individual units are designed with a proper conception of the relationship of one house to another.

Building Materials.—Naturally the relative cost has a strong influence upon making a selection of various materials, and in many cases proves to be the determining factor. Many other considerations, however, must be carefully noted, even though they may lead to greater expense, for, after all, we are not looking for the cheapest house in point of first cost only, but the cheapest housing which can be devised and still satisfactorily meet the conditions of the individual problem.

Local Environment.—The diverse nature of communities and the variation in climatic conditions of different localities speak

for different types of buildings. Domestic architecture has resolved itself into a comparatively few set styles, which demand the use of certain specified materials, in order to retain the characteristics necessary to the styles.

Each locality shows a marked preference for some one or more of these styles, and, upon a careful analysis, it will be found the adoption of one by a locality has not been occasioned so much by a mere preference for the general appearance obtained as by a process of reasoning in the attempt to discern the demand of the environment. Availability of building material is one good reason for the adoption of a style, as the cost of a material close at hand will generally be less than cost plus transportation for some other distant material.

The nature and location of the enterprise will exert an influence. For instance, it seems unwise to build frame or stucco houses in a development located in the heart of a great mill district, as for instance the steel mills of Pittsburgh. The deterioration in appearance would involve an abnormally high upkeep cost if the houses were to be properly maintained. Climatic conditions also narrow the choice. Developments in localities offering long, uninterrupted seasons of warm weather and brilliant sunshine must certainly be treated differently from those in cold weather climates, subjected to long periods of gray days and extreme cold.

There is another reason for adopting a style for a development, which, although not substantiated by practical considerations, nevertheless is important; it is the architectural tradition of the region. To fully appreciate what this means we have only to imagine the ill favor it would occasion were we to foist upon a New England village, rich in its store of old colonial houses or examples of cottages, a development executed in the style of rows so commonly encountered in the Middle West, or made up of an assemblage of California bungalows.

The degree of the building density contemplated for a development, with the controlling low or high land values, will be directly reflected in the style of architecture employed. For instance, the bungalow, so popular in southwestern United States would be an ill-chosen type for a congested manufacturing district of the Central States. In the one case one can afford to spread out, while in the other, in order to house as many people as possible, it is necessary to utilize all of the land.

Low Maintenance versus Personal Preference.—In apparent contradiction to the ideas advances for selection of architectural styles and the employment of materials, there is found in every locality and section of the country examples of architecture which tend to disprove all that has been said. Such examples rather add to the force of the arguments, as they are for the most part isolated instances which have been dictated by personal preference. It is, therefore, principally in the development which is to be on a renting basis that one may feel more free to suggest standardizing types and methods.

Personal preference of the prospective individual home owner may cause unwise selection of materials and style, which may lead to unsatisfactory results and high maintenance costs; the magnitude of which only becomes glaring in large holdings. The individual may have such a strong preference for a frame house that he will be willing to withstand the expense of painting every few years, and of replacing portions of the house which may have deteriorated. But, if this be multiplied by five hundred or more houses, the cost is both amazing and sufficiently important to make provisions to minimize maintenance costs, after all, the most important consideration in both the selection of materials and styles of architectural treatment.

The Concrete House.—Concrete houses are much in favor in certain localities and with some interests. The pronounced advantages are stability, durability, fire and vermin-proof qualities, freedom from repair and general upkeep. They have been objected to in the past because of excessive cost, dampness, rigidity of floor surface and lack of variety in treatment. Many of these difficulties have been eliminated in recent construction and concrete housing is growing in favor where large developments permit the use of machine methods.

Concrete building, either by use of blocks, repetition of forms, or by the unit slab method, permits the utilization of large scale production methods. It avoids many difficulties with labor by freedom of necessity of coördinating and assembling several trades on the same job and by permitting the use of common labor to a large extent. The expense of construction may, therefore, be well within that of other materials, and when annual costs are considered, the use of concrete is likely to compare favorably.

It is particularly adaptable to group, row and apartment construction, to which its sound- and fireproof qualities are well

adapted. It is a mistake to treat concrete surfaces in strained imitation of some other material, and acceptable taste and good art are best developed by giving good expression to the material used. Harmony, variety and architectural excellence can be obtained and the use of concrete in the future may well be considered in industrial housing.

Details of Construction.—To discuss here the mass of details which make up a satisfactory house is beyond the intent of this chapter, but it would seem necessary to warn against some of the common mistakes observed in much of the present housing.

For example, frequently, to save material, roofs have been given insufficient pitch, with the result that leaky roofs are a common complaint, especially when poor covering has been used. The roof should have a pitch of not less than 5 in. in 12 in. for porches and not less than 6 in. in 12 in. for regular house roofs. Care should be exercised, in laying the asphalt shingle roof, to see that the shingles are securely nailed; especially when the four-in-one strip shingle is used. Careless workmen are apt to use only two nails. The result is that the roofing material blows up, especially on low pitches, and leaks occur.

Simplicity of roof construction, with as few dormers as possible, is recommended; both because of the expense involved and the danger of leaks where vertical sides come in contact with the roof, requiring flashing. Flat roofs and decks should be avoided as much as possible, and when used should be covered with a good grade of tin, preferably a copper bearing tin or where practicable a guaranteed composition tar and gravel roof. The use of tin is also recommended for flashing occurring on vertical walls, but the valleys might better be formed by using rubberoid or some such material. This will eliminate the possibility of deterioration through rusting out.

It is inadvisable to run stucco walls down to grade level as frost cracks and spalling of the material are bound to result. Basement walls, when constructed of concrete, should contain 10 per cent. hydrated lime to act as an integral waterproofing. Even when this is done, and especially when other kinds of basement walls are employed, they should be well designed and constructed to insure tightness. If, upon inspection, much dampness is evident, there should be an application of a membrane system of waterproofing applied on the exterior of the wall, and where the wall abuts a grade, in which there is evidence of a run of sub-

surface drainage, a French drain should be provided to relieve water pressure against the wall.

Great care should be exercised in the laying up of the flue linings in chimneys, in order to see that the joints rest in an even full bed of mortar and that the void between the brickwork and the tile lining is flushed solid. The importance of this provision cannot be too strongly recommended, as faulty flues cause endless trouble and are extremely hard to correct.

In brick houses it is well to see that the sills of windows are well bedded in a neat cement grout to prevent rain driving under the sills. The staff mould on all windows should be carefully designed, not only to insure a proper amount of space for applying screens, but also to give enough cover at the joints to take care of irregularities in brickwork due to short chipping and poor jointing.

Wooden construction for porches should be eliminated as much as possible and foundations for porches should be of masonry.

Simplifying the exterior millwork is recommended, so as to use as little wood as possible; as, not only is the first cost reduced, but also maintenance costs, since there is less chance of deterioration and less woodwork to paint. Likewise, in the interior, as little wood as possible should be used. Three and one-half inch plain trim is, if anything, better than larger or more elaborate finish and reduces the cost of millwork and upkeep.

Finally, a word of warning should be sounded against buying too cheaply, in the hope of reducing costs. Very cheap material will be found to effect no economy, because the costs of working it up and the wastage are so great.

Cost of Materials in Construction.—The item of cost is the question of greatest interest to the investor and owner, and, in consequence, one is continually confronted by the query—"Which is cheapest, the brick house, the frame house, or the stucco house, and what is the difference?"

To avoid complicating the matter at the outset, we will consider brick, stucco and frame as general classifications, although each of the three is subject to wide variation and utilizes material of the other class. For instance, what is commonly known as the brick house may have solid 9 in. brick walls, or have 4 in. of brick veneered on regular studded inner walls, or have 4 in. of brick backed up with hollow tile; likewise, the other constructions are subject to many modifications, which affect the cost.

Generally speaking, the brick house is more costly than stucco, and stucco in turn is more costly than frame, but as to the exact difference in the cost there is a great divergence of opinion. This is not due so much to ignorance on the part of those who should be informed on the subject, but rather to the fact that the cost of materials is different in different localities. The cost of a material at a given site is dependent upon cost at the source of supply, plus transportation. It is thus a difficult matter to offer any comparison of costs of materials, which can be of value for general application. Furthermore, the present condition of the markets as to prices make it hazardous to give a price today which will be of value tomorrow.

Even though these limiting conditions must be admitted, the desire to have some detailed information, to be used in arriving at conclusions on the question of the comparative cost of different methods of construction employing various building materials, has led to the formulation of the following tabulated data. The general method has been to estimate accurately the quantity of materials entering into each method of construction, and to apply current market prices f.o.b. the source of the material in question. Labor cost has been estimated and present union wages applied for each kind of labor involved in the various operations. As far as change in wages is concerned, it will usually be found that a change in one trade is followed by a general modification in the wage scale, and the relation is thus main-

TABLE 38.—COMPARATIVE ESTIMATED COSTS PER SQUARE FOOT OF WALLS OF VARIOUS MATERIALS

Place	Materials	Dimensions	Cost per sq. ft. in cents
Basement and foundations	Concrete	9″ thick	30
	Hollow tile	8″ × 12″ × 12″	29
Superstructure	Brick backed with tile	4″—4″ × 12″ × 12″	49
	Brick with furring	9″ thick	58
	Brick veneer	4″—sheathing	49
	Stucco on tile	5″ × 8″ × 12″	41
	Stucco on metal lath	Studs and sheathing	34
	Stucco on wood lath	Studs and sheathing	32½
	Siding on sheathing	6″ lap	30
	Siding on studs	6″ lap	23
	Shingles on sheathing		40

tained fairly constant. Finally, the estimate has been resolved into a common unit, namely, the cost of 1 sq. ft. of superficial wall area. These data are for the spring of 1920 in the Pittsburgh district and cannot be used for other parts of the country without recalculation from the original data. The comparison is presented in the preceding table.

Tabulation of House Costs.—In addition to the information given in the above table, data on the cost of houses in various sections of the United States will serve as a good indication, not only of the relative costs of various types of dwellings, employing different materials, but also will prove interesting, as an indication of the general advance in cost of building in the last few years. A list of houses with their approximate costs appears in the following table:

TABLE 39.—INFORMATION CONCERNING COST OF HOUSES IN DIFFERENT LOCALITIES

Locality	Type	Number of rooms	Construction	Approximate estimated cost	Date
Bridgeport, Conn.	Semi-detached	4 and bath	Common brick	$3203 to 3471	1918–1919
Bridgeport, Conn.	Row	3 and bath	Common brick	3067	1918–1919
Bridgeport, Conn.	Row	4 and bath	Common brick	3798	1918–1919
New London, Conn.	Detached	5 and bath	Frame	3900 to 3954	1918–1919
New London, Conn.	Semi-detached	5 and bath	Frame	4011	1918–1919
Waterbury, Conn.	Detached	6 and bath	Stucco	4794	1918–1919
Waterbury, Conn.	Semi-detached	6 and bath	Stucco	4755	1918–1919
Rock Island, Ill.	Detached	4 and bath	Frame	3910	1918–1919
Rock Island, Ill.	Detached	5 and bath	Frame	4434	1918–1919
Bath, Maine	Detached	6 and bath	Concrete	4378 to 4819	1918–1919
Bath, Maine	Detached	5 and bath	Concrete	3907	1918–1919
Bath, Maine	Semi-detached	3 and bath	Concrete	2859	1918–1919
Aberdeen, Md.	Detached	6 and bath	Frame	4595	1918–1919
Aberdeen, Md.	Detached	6 and bath	Frame	4475	1918–1919
Aberdeen, Md.	Row	4 and 5 and bath	Frame	3575	1918–1919
Indian Head, Md.	Detached	6 and bath	Frame	3276 to 3330	1918–1919
Lowell, Mass.	Detached	5 and bath	Frame	2361	1917
Lowell, Mass.	Semi-detached	4 and bath	Frame	1932	1917
Worcester, Mass.	Detached	6 and bath	Frame	3188–3791	1915–1916
New Brunswick, N. J.	Detached	6 and bath	Hollowtile, stucco	4549	1918–1919
New Brunswick, N. J.	Semi-detached	5 and 6 and bath	Hollowtile, stucco	4009 to 4173	1918–1919
Passaic, N. J.	Row	4 and bath	Frame	1600	1918
Passaic, N. J.	Row	6 and bath	Frame	2200	1918
Watertown, N. Y.	Detached	5 and 6 and bath	Frame	3230 to 4353	1918–1919

TABLE 39.—*Continued*

Locality	Type	Number of rooms	Construction	Approximate estimated cost	Date
Watertown, N. Y.	Semi-detached	5 and bath	Frame	$3945	1918–1919
Akron, Ohio......	Detached	5 and 6 and bath	Brick-stucco-tile	House and lot 2400 to 3600	1917
Niles, Ohio.......	Semi-detached	5 and bath	Frame bungalow	3808	1918–1919
Niles, Ohio.......	Detached	5 and 6 and bath	Frame	3780 to 4590	1918–1919
Erie, Pa.........	Detached	5 and 6 and bath	Brick, tile and stucco	4766 to 5593	1918–1919
Erie, Pa.........	Semi-detached	5 and 6 and bath	Brick, tile and stucco	3018 to 5680	1918–1919
Erie, Pa..........	Row	5 and 6 and bath	Brick, tile and stucco	4869 to 5179	1918–1919
Pittsburgh District, Pa.......	Detached	5 and bath	Common brick 4″ back up tile	4300	1918–1919
Pittsburgh District, Pa.......	Detached	6 and bath	Common brick 4″ back up tile	4700	1918–1919
Pittsburgh District, Pa.......	Detached	7 and bath	Common brick 4″ back up tile	5000	1918–1919
Pittsburgh District, Pa.......	Semi-detached	5 and bath	Brick-tile	4100	1918–1919
Pittsburgh District, Pa.......	Semi-detached	6 and bath	Brick-tile	4500	1918–1919
Pittsburgh District, Pa.......	Row	4 and bath	Brick-tile	3100	1918–1919
Pittsburgh district	Row	5 and bath	Brick-tile	3800	1918–1919
Pittsburgh district	Row	4 and 6 and bath	Brick-tile	3800–4500	1918–1919
Nanticoke, Pa....	Semi-detached	6	Poured concrete	1160	1912
Williamsport, Pa.	Row	4	Stucco on Expander Metal	1472	1916
Newport, R. I....	Semi-detached	5 and 6 and bath	Frame	3328–4584	1918–1919
Newport, R. I....	Detached	6 and bath	Frame	4470	1918–1919
Craddock, Va....	Detached	5 and bath	Frame	3222–3447	1918–1919
Craddock, Va....	Detached	6 and bath	Frame	3654–3974	1918–1919
Craddock, Va....	Detached	7 and bath	Frame	4415	1918
Craddock, Va....	Semi-detached	4, 5, 6, and bath	Frame	2460–3335	1918
Craddock, Va....	Row	6 and bath	Frame	3675	1918–1919
St. Albans, W. Va.	Semi-detached	4 and 6 and bath	Frame, steam heat	1500–1600	1916
Charleston, W. Va.	Semi-detached	4 and 5 and bath	Stucco on tile	2672–4495	1918–1919
Charleston, W. Va.	Detached	6 and bath	Stucco on tile	3900–4608	1918
Charleston, W. Va.	Detached	8 and bath	Stucco on tile	6165	1918

DETERMINATION OF ACCOMMODATIONS REQUIRED

The following development of the method of arriving at the required number and grades of houses and quarters for families and unmarried workers is illustrative of the procedure to be followed in applying the suggestions made in this and the following chapter. The data as to the number and classification of the employees and the wages paid, while corresponding to actual conditions now prevalent, are not susceptible of general application, owing to the variations present in any particular case, but the presentation of the outline of the method may be helpful in making similar surveys of housing requirements.

A town site is assumed for an industrial plant, in which it is estimated 5000 people will be directly employed. The determination of number of houses and other accommodations required is based on the number on payroll. The determination of the grades and types of houses is based on the wages of employees.

Forecasted Payroll.—A forecast of the immediate payroll, divided into skilled and unskilled labor and showing the number of married men, single men, women and minors of both native and foreign workers, is shown on the following table.

TABLE 40.—FORECASTED IMMEDIATE PAYROLL

Class of labor	Skilled labor				Unskilled labor				Total workers
	Men		Women	Minors	Men		Women	Minors	
	Married	Single			Married	Single			
Native	800	200	50	0	200	800	150	300	2,500
Foreign	200	300	0	0	50	1,800	0	150	2,500
Total	1,000	500	50	0	250	2,600	150	450	5,000

The following table shows the forecasted payroll subdivided according to wage scale.

TABLE 41.—FORECASTED PROPOSED WAGE SCALE

Classification	Under $3	$3 to $4	$4 to $5	$5 to $6	$6 to $7	$7 to $8	$8 to $9	$9 to $10	Over $10
Married skilled native workmen	...	....	...	50	150	250	150	100	100
Married unskilled native workmen	...	100	75	25	...	...	...	...	...
Married skilled foreign workmen	...	....	...	50	85	30	20	10	5
Married unskilled foreign workmen	...	40	10	...	...	...	...	...	...
Total married workmen	0	140	85	125	235	280	170	110	105
Unmarried skilled native workmen	...	....	...	10	30	70	40	30	20
Unmarried unskilled native workmen	...	600	150	50	...	...	...	...	...
Unmarried skilled foreign workmen	...	....	50	150	50	30	20	20	...
Unmarried unskilled foreign workmen	...	1,200	600	...	...	...	...	...	...
Total unmarried workmen	0	1,800	800	210	80	100	60	30	20
Skilled native women workers	...	....	40	10	...	...	...	...	...
Unskilled native women workers	...	125	25	...	...	...	...	...	...
Unskilled native minors	250	50	...	...	...	...	...	...	...
Unskilled foreign minors	140	10	...	...	...	...	...	...	...
Total women & minors	390	185	65	10	0	0	0	0	0
Grand total	390	2,125	950	345	315	380	230	140	125

Number and Grades of Houses Required.—Grade C houses will be provided for married workmen receiving less than $7.00 per day. The Grade B Houses will be provided for married workmen receiving from $7.00 to $9.00 per day. The Grade A houses will be provided for married workmen receiving $9.00 and more.

Table 41 shows that there are 585 married men receiving less than $7.00 per day; 450 married workmen receiving from $7.00 to $9.00 per day; 215 married workmen receiving $9.00 or more

per day. Therefore, there will be required 585 Grade C; 450 Grade B; and 215 Grade A Houses.

Quarters Required for Single Workmen.—The number of rooms required for single men is based on the number of single

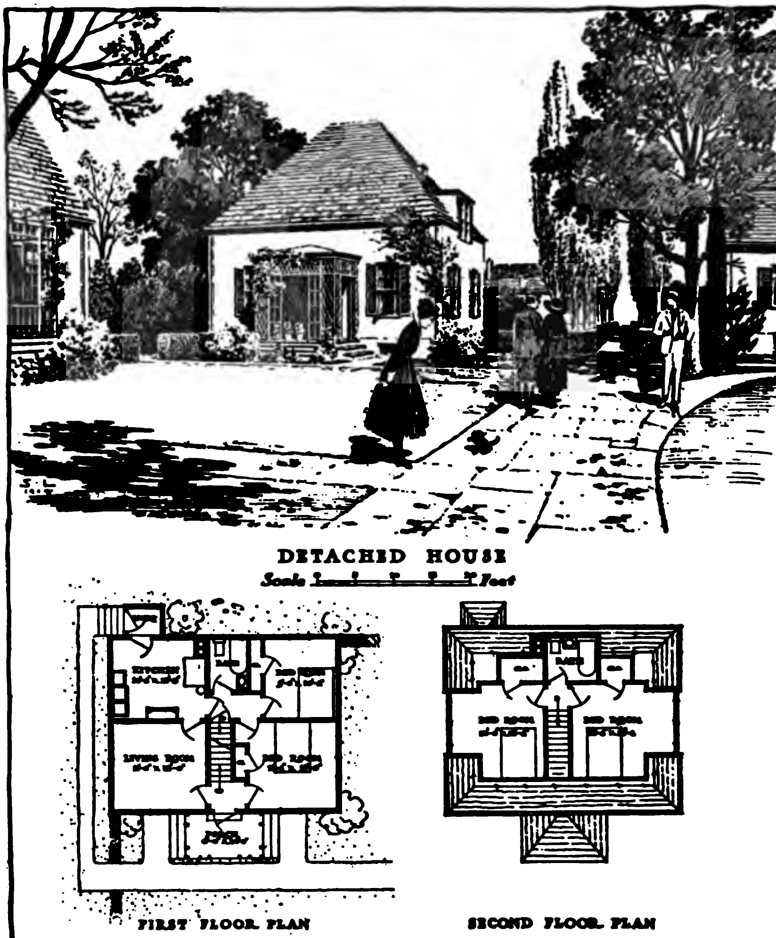

FIG. 51.—Small boarding house of the type built at the Wyandotte, Michigan, project of the Emergency Fleet Corporation; effective separation between the family and the boarders is secured.

men on the forecasted payroll. The grades of rooms to be provided are based on the wages received by the single men and also whether they are native or foreign workmen.

On this basis six grades of rooms are to be provided as follows:

Grade U for high wage native single workmen.
Grade V for medium wage native single workmen.
Grade W for low wage native single workmen.
Grade X for high wage foreign single workmen.
Grade Y for medium wage foreign single workmen.
Grade Z for low wage foreign single workmen.

In estimating the number of rooms required for single men, an allowance must be made for the single men living in family houses either as members of the family or as lodgers. It is assumed that a larger number of workers per house will be accommodated in Grade C houses, than in Grade B or Grade A houses. Also, that houses occupied by foreign families will have a larger number of workers per house than those occupied by native families Fig. 51 illustrates how this is accomplished with suitable privacy. The following assumptions are made in estimating the number of workers per house, other than head of family, women workers and minors.

TABLE 42.—ESTIMATED NUMBER OF SINGLE WORKERS LIVING IN FAMILY HOUSES NOT INCLUDING WOMEN WORKERS AND MINORS

Grade	Occupant	Number of houses	Assumed distribution of single workers in houses	Resultant number of single workers in family houses
A	Native family..........	200	1 in 10	20
B	Native family..........	400	1 in 4	100
C	Native family..........	400	1 in 2	200
A	Foreign family.........	15	1 in 5	3
B	Foreign family.........	50	1 in 2	25
C	Foreign family.........	185	1 in 1	185
	Total..............	1250		533

If in addition to the above total of 533, the 150 unskilled native women workers and the 450 minors are assumed to live with families, the total so accounted becomes 1133 people, in addition to 1250 heads of the families. That is, there are 2383 workers living in the 1250 houses, or 1.9 workers per house. The U. S. Housing Corporation in planning their projects assumed 1.7 workers per house.

There are 840 native single workmen receiving less than $7.00 per day. One of every two of the 400 Grade C houses, occupied by native families, will accommodate one additional single man,

either as a member of the family or as a lodger, so that there will remain 640 native single men to be provided with Grade W quarters. Assuming that 2 men will occupy one room there will be required 320 Grade W rooms.

There are 110 native single workmen receiving between $7.00 and $9.00 per day. One of every four of the 400 Grade B houses for native families will house a single man, so that there will remain 10 single native workmen to be provided with Grade V quarters. Assuming that one man will occupy a room, there will be required 10 Grade V rooms.

There are 50 native single workmen receiving $9.00 or more per day. One of every 10 of the 200 Grade A houses for native families will house an additional single man, so that there will remain 30 single native workmen to be provided with Grade U quarters. Assuming that one man will occupy one room there will be required 30 Grade U rooms.

There are 2050 foreign single workmen receiving less than $7.00 per day. Each of the 185 Grade C Houses for foreign families will house an additional foreign single workman, so that there will remain 1865 foreign single workmen to be provided with Grade Z quarters. Assuming that two men will occupy one room, there will be required 932 Grade Z Rooms.

There are 50 foreign single workmen receiving between $7.00 and $9.00 per day. One of every two of the 50 Grade B houses and one out of every 5 of the 15 Grade A houses for foreign families will house an additional foreign single workman, so that there will remain 22 foreign single workmen to be provided with Grade Y quarters. Assuming that 2 workmen will occupy one room, there will be required 11 Grade Y rooms.

There are no foreign single workmen receiving $9.00 or more per day, so that no Grade X quarters need be provided.

Quarters for Women and Minors.—It is assumed that 50 of the 200 women employees must be provided with single quarters. Allowing one woman for each room there will be required 50 special rooms for women employees.

It is assumed that the 300 native minors and the 150 foreign minors will live with families so that no single quarters will be required for them.

Summary of Houses and Rooms Required.—Below is shown tabulated number and grades of houses and rooms required:

Grade *A*	Houses for Native Families	= 200
Grade *B*	Houses for Native Families	= 400
Grade *C*	Houses for Native Families	= 400
Grade *A*	Houses for Foreign Families	= 15
Grade *B*	Houses for Foreign Families	= 50
Grade *C*	Houses for Foreign Families	= 185
Grade *U*	Rooms for Native Single Workmen	= 30
Grade *V*	Rooms for Native Single Workmen	= 10
Grade *W*	Rooms for Native Single Workmen	= 320
Grade *X*	Rooms for Foreign Single Workmen	= None
Grade *Y*	Rooms for Foreign Single Workmen	= 11
Grade *Z*	Rooms for Foreign Single Workmen	= 932
Special Rooms for Women Employees		= 50
Rooms for Minors		= None

CHAPTER XI

BUILDINGS OTHER THAN HOUSES

QUARTERS FOR SINGLE MEN—QUARTERS FOR SINGLE WOMEN—STORES AND APARTMENTS—SPECIAL SERVICE BUILDINGS—BUILDINGS FOR SOCIAL NEEDS

Introduction.—Buildings to supply the physical wants and the social needs of a community are secondary in importance only to the dwelling houses themselves. Their necessity is more urgent in the rural than in the urban development, due to the fact that the latter is nearby to established facilities of this kind. A decision on what buildings (hereafter referred to as Special Service Buildings) are necessary in a given development, must be made before the general plan can be put into effect. The location of such buildings must be a part of the scheme of the town plan; but the design of the separate units in the specified locations and the relation to the general housing project must be the work of the architect. It is this phase of the problem which will be discussed in this chapter.

Character of Special Buildings.—Under "Special Buildings" the following lists of buildings will be discussed:

Buildings which supply physical needs are:—	Buildings which supply social and ethical needs are:—
Quarters for single men	School houses
Quarters for single women	Assembly hall
Stores	Churches
Laundry	Community house
Bakery	Club houses
Refrigerating Plant	Gymnasia
Hospital	Theatres

The problem of drawing up programs for all such buildings, in terms of the service they should render, confronts one at the outset. As to the buildings designed to cater to the physical needs, one can intelligently forecast what the limiting conditions

of the program should be, as there is tangible information to guide. Concerning the buildings designed to supply the social needs, as such are products of the personal element, which in a new development are unknown factors, a wise decision is more difficult.

The method of management of the development, and the nature of the investment—whether the houses are to be rented or sold—must also be considered in making provision for these buildings. If the building company is to retain ownership of houses and institutions and manage the community, then it may more readily predetermine the character of these special buildings. This method of management, however, has been unsuccessful in many cases, as people and particularly Americans, resent being directed without participating in the government; and they also dislike having their amusements prescribed for them.

The result often has been that the social features, offered at considerable expense, have been practically rejected by the people. In view of this fact, would it not be better merely to allot suitable space for such features and forget about the design or construction of them until such time as plans can be intelligently formulated? Then such will not only reflect the desires of the people to be served, but also allow their participation in the development of the plans. Approaching the matter in this way, one may overcome the backwardness the workman feels in accepting a service from others which smacks of paternalism, or possibly of disguised charity.

The character, size and general plan of the buildings will be determined by the service they offer and the number and class of people to receive such service. The next step must be a decisicn regarding the kind of construction and the building materials to be employed.

Building Materials.—The fact that the buildings are for the most part larger than the house units tends to intensify lack of harmony between them and the dwellings. For this reason care must be exercised, not only in the selection of materials, but also in the expression of architectural treatment, in order to insure no discordant notes, or feeling of intruded commercialism in the general scheme. As to appearance, it should, by employing somewhat the same materials and architectural style, conform to the general character of the development.

In regard to the question of economy, in building and maintenance costs, that which is true of the general housing program will also obtain for special buildings.

The motives which impel the provision of special buildings, together with the requirements to insure satisfactory results, will now be discussed.

QUARTERS FOR SINGLE MEN

The number of single men employed in industrial plants varies with the character and location of the industry. To provide for the housing of these men it will be necessary to consider the total number and the class of men to be housed, in order to erect satisfactory quarters for each.

Formerly, the only provision for taking care of single men was by means of isolated camps, as no other accommodations were available. In settled districts, the single men, with the possible exception of the lower grades of common labor, who were housed in crowded bunk quarters, were left to find lodging places wherever they could do so. This has led to the result that the great majority were taken in as lodgers by private families. The lack of proper accommodations and congenial surroundings provokes restlessness and dissatisfaction among the single workers, and results in a high percentage of labor turnover.

This condition has prompted many industrial concerns to study the housing of the single worker with as great care as that of his married brother. As a consequence of such study, it is generally believed that there should be three distinct grades of quarters for single men, which may be considered as analagous to the grades suggested for married men and will be referred to as Grades D, E and F.

Boarding Houses.—The most generally accepted type of building for the low and middle classes of labor, Grades F and E, respectively, is the "Boarding House". A literal view of the term "Boarding House" might lead to the impression that these houses were to serve merely as eating places, which is not the case, as they offer the facilities for both dining and lodging. The lower priced the grade of labor to be housed, the larger the unit for this purpose; the reason being one of cost. Since less rental can be expected from the low paid workman than from those receiving higher wages, the building costs must likewise be held down; group life accomplishes this. The same arguments as to

costs, which obtained in the case of single and multiple dwelling houses, will apply here with equal force; the greater the number of rooms under a single roof, the less the cost per room, for the reason that not only are building costs reduced, but also a saving in land and operation is effected. The size of the units is a question for each development to decide for itself, in consideration of the number of men of different classes to be housed and the policy of the company as regards the operation of the units.

Two methods are suggested regarding types of boarding houses and the policy of the company concerning the operation of such units.

First,—small units, designed in such a way as to provide accommodations for a family who shall run the house, and in addition a separate portion of the building for boarders.

Second,—large units which shall be managed directly by the company.

Small Boarding Houses.—This type should not house more boarders than the housewife can conveniently take care of without interference with her own domestic duties. The house must be so designed that the seclusion of that portion of the dwelling occupied by the family shall be complete; this will necessitate a separate entrance for the boarders and means of circulation from their living quarters to the dining room without passage into or through the family apartment. Although double rooms for boarders are more economical than single rooms, the latter are far more desired by the tenants and generally more satisfactory. Each boarder's room should have a clothes closet. An interesting design of a small boarding house is shown in Fig. 51.

No separate recreation room need be provided, as the general dining room may readily serve for this purpose. In such case, however, a separate dining room for the family should be provided, or, in the cheaper grade, the kitchen may be made large enough to allow its use for dining purposes.

Ample toilet room facilities should be provided for the use of boarders, arranged so as to be separate from similar accommodations for the family use.

Heating, lighting and ventilation should be the same as before suggested for single house types of the corresponding grade.

Larger Boarding Houses.—The operation of the larger boarding house should be directed, if not controlled, by the company. This is best accomplished by putting the building in charge of a

custodian, who should reside in the building and be solely responsible for its satisfactory operation in every particular. Such an unit is shown in Fig. 52.

The office of the custodian should be located in such a position, on the ground floor, as to enable him not only to watch the main entrances, but also the entrance to the dining room. If the building is large enough to warrant such an arrangement, the bedrooms should be in wings, separated by a central structure in which the dining hall may be located on the first floor and a large recreation hall directly above it on the second floor. When such a plan is used, there should be a corridor providing circulation from one wing to another so that the dining hall need not be used for this purpose.

FIG. 52.—A boarding house for the accommodation of forty laborers.

There should be stairways in each wing, preferably placed so as to start from the circulating corridor and to land at a point centrally located in the second floor. This will necessitate the least amount of travel to reach the greatest number of second floor rooms and main recreation hall, and will cause the minimum circulation past bedrooms. Dark portions of the buildings should be used for storage space and toilet units, provided adequate window area can be planned in the latter case. Provision should be made for porches, or at least some space where

the men can sit out-of-doors. The kitchen service to the dining room should be as direct as possible, preferably through a pantry; it should, in addition, be so placed as to be readily accessible from the service yard.

Requirements of Different Grades.—The different grades of buildings will be indicated by the extent of facilities furnished and, therefore, by the expense of construction; the lesser equipped buildings being for lower waged workmen and the more expensive for the higher priced ones.

Grade F Buildings.—A cellar under the entire building is not essential, but that which is provided should be equivalent to the following:

The minimum height should be 7 ft., well lighted and cross ventilated. The floor should be of cement, sloped to drains.

In portions where the cellar is omitted, the building should be set up on masonry walls or piers which must be carried below frost line. The clear air space in such portions should be 2 ft. in height, enclosed and ventilated, with provision for ground drainage.

Buildings under four stories in height need not be fireproof in general construction, but when over three stories they should be fireproof throughout. In buildings of three stories or less, having an area exceeding 3,000 sq. ft., there should be fire walls constructed of brick, terra cotta, stone or concrete placed in such a manner that no portion with an area of more than 3,000 sq. ft., should exist unless enclosed by such fire walls. Furthermore, in buildings of this type, when so arranged that sleeping quarters occur in wings, radiating from a common central structure, each such unit, regardless of whether it exceeds the area before called for, should be separated by fire walls. Stand pipes with hose reels should be provided, so that any portion of the building can be reached with 75 ft. of hose.

In two story buildings, no other means of egress than the regular stairs and stair halls, as hereinafter called for, need be provided, but in structures of three stories or more, adequate means of passage to the street or yard should be provided, either by additional stairs enclosed in fireproof walls, fire tower or stairway fire escape. All such additional means of egress should be remote from the main stairs, and located so that no room shall be more than 40 ft. distant. When exterior metal fire escapes are used, they should be reached through fireproof self-closing

doors, made to swing out, and landings on such should be so arranged that descent will not require persons to pass in front of windows.

All stairs and stair halls should be not less than 3 ft. wide in the clear and when enclosed in fire walls, as above called for, doors should swing out toward the stair hall, so as not to obstruct free passage.

Dumb waiters and elevators should have their own separate enclosure with fireproof doors.

Unless connected with a central heating plant, provision should be made for independent low pressure steam heating. Radiators in bedrooms should be placed under windows.

One water closet for every 12 men, one urinal per 16 men, one lavatory per 8 men and one shower per 10 men are necessary. Bathtubs are not absolutely necessary. All toilet rooms should have the floor surfaces of an impervious material other than concrete. A toilet should be provided in the basement for use of such workers and attendants as occupy that part of the building.

Each floor should have a separate toilet room, with sufficient fixtures to conform to the listed requirements. In cases where isolated or partially isolated wings occur, additional toilet rooms should be provided, so that the lodgers may reach a toilet without going outside the wing in which they are housed. The placing of lavatories and showers in a room separate from toilets and urinals, while not a minimum requirement, will be found a more satisfactory arrangement; and, so arranged, that the rooms are communicating. All toilet and bathrooms should have windows opening directly to the outer air. Separate service closets, with slop sinks, should be provided one to each floor, or more where isolated conditions as stated above occur.

Adequate provision should be made for housing the permanent servants of the building and also the custodian or superintendent. These quarters, together with their toilet accommodations, should be entirely isolated from that portion of the building occupied by lodgers. The general dining hall, recreation room, office for the custodian, kitchen, pantry and servants' dining room should be provided. The size of all such rooms will be dependent upon the number of men to be accommodated. All public rooms, such as dining hall, recreation rooms and corridors should have heights of 9 ft. to 12 ft.; bed rooms should have a minimum height of 8 feet.

The number of rooms is not subject to determination here, but bed rooms should be designed as single rooms. These should have a minimum area of 70 sq. ft. and a minimum width of 7 ft. They should be designed so as to allow for the minimum furniture called for in the following list:

Single bed, 3 ft. 3 in. × 6 ft. 6 in.

Combination wardrobe and dresser, 2 ft. 0 in. × 3 ft. 6 in.

Writing table, 1 ft. 6 in. × 2 ft. 6 in.

One chair.

The furniture should be indicated carefully to scale on the plans. Built-in clothes closets for the bedrooms need not be a minimum requirement.

Each single bedroom should have at least one window, with a free area of 12 square feet. Doors to bedrooms should, when possible, be placed opposite one another, and should have transoms, or louvers.

Buildings should be wired for electricity. Corridor lights, and illumination in the dining hall and recreation room should be controlled from a panel board, located in or close to the custodian's office. Bracket lights should be provided in bedrooms, in such location as to furnish light at the dresser, these lights to be controlled at the fixtures. Other lights should be controlled by switches conveniently located.

It is suggested that base plugs be provided in corridors, dining rooms, recreation rooms, kitchen and laundry, for the purpose of connecting up such electrical appliances as may be needed in cleaning. At points close to stairs, fire exits and hose reels, gas pilot lights protected with red shades should be provided in full view from the corridor.

Grade E Buildings.—In addition to the minimum requirements listed for Grade F buildings, the following should be provided for those of Grade E.

The bath should be separated from general toilet. At least one bathtub should be provided, in addition to showers.

Bedrooms should have a minimum area of 85 sq. ft., with a minimum width of 8 feet.

Clothes closets should be directly connected with bedrooms.

Lights for bedrooms should include, in addition to bracket fixture, a ceiling light controlled by switch at door.

Grade D Buildings.—The single men, for whom the Grade D buildings are designed, will be the more highly skilled mechanics,

shop foremen, minor superintendents and the higher salaried office employees. These demand higher standards of living and insist upon a type of building and policy of operation which will permit an expression of their individuality. This leads to a desire for a smaller and more intimate type of dwelling place, where occupants may enjoy a close comradeship. This is best accomplished in a building operated by the residents themselves as a club house. The positions occupied by this class, being of a more permanent character, create a desire on the part of the men for congenial, homelike living quarters, in which they can feel a personal controlling interest.

This grade, therefore, should have a comparatively large room, to be used as a general living or reading and smoking room. In addition, another good sized room should be provided in which a billiard or pool table, card tables, and games can be accommodated.

The bedrooms should be larger than in Grade E or F houses, in order that more furniture may be comfortably arranged. Toilet and bath accommodations should be more amply provided. The building generally should have a more domestic, homelike character than the larger, lower grade boarding houses, the very nature of which precludes the possibility of overcoming the feeling of institutionalism which always exists.

QUARTERS FOR SINGLE WOMEN

Special buildings for housing women will in most developments be found unnecessary. In many cases a few single women will readily find quarters as lodgers with private families. However, there are some industries which employ women almost exclusively, and it will be necessary to provide suitable quarters for them, especially since the great majority of these workers are young girls, many of whom have left homes in other localities in order to obtain employment. The result of providing such quarters will accomplish great attendant benefits in the happier social life and companionship, not to speak of moral and social protection which the girls enjoy.

Management of Boarding Houses.—The operation of these units is similar to the corresponding units for men, with the difference that a matron officiates as the custodian. It is suggested that, in the operation of this type, it will be found that a

board of control, elected by the lodgers from their own number and working with the matron, will greatly facilitate the problems of management and eliminate friction between the authoritative agency and those enjoying the privileges offered by such housing.

Requirements of Boarding Houses.—The subject of quarters for women workers will be considered under one general grade. All requirements relating purely to the building technique, such as fire protection, minimum story heights, heating, lighting, ventilation, cellars, windows, room sizes and materials, may be governed by the same suggestions as offered under "Quarters for Single Men".

Requirements for rooms should be the same as those listed for men's units, except that bathrooms and toilet rooms must be separated, though arranged to communicate.

A kitchenette and a sewing room should be provided on alternate floors. Trunk rooms should be supplied, as minimum sized bedrooms will not accommodate all the belongings of the lodger.

First floor should have matron's office, so placed as to oversee main entrances, access to sleeping quarters and entrance to dining room. There should be provided, in addition to main recreation or assembly room, one reception parlor for every twenty women. These may be arranged so as to form one large reception room when so desired.

Minimum provision for plumbing should be:—one water closet per ten women; one shower per ten women; one lavatory per six women; one bath tub per twenty-five women. Requirements other than these should be the same as suggested for men's units. Toilet accommodations, with quarters, for the matron and resident help should be provided.

Laundry facilities, sufficient to enable the lodgers to do washing of clothes, should be provided in the basement.

The kitchen should have outside access, and be separated from the dining room by a service pantry.

STORES AND APARTMENTS

The reason for including stores as a part of the necessities is because of the partial or complete isolation of the usual industrial development from such necessary service units. The element of isolation may require, in connection with the store, provision for

living quarters to accommodate the store owner or whomsoever shall have charge of the business. In some instances it will be found economical to arrange a store room as a part of a regular private dwelling house. The size of store room thus obtained, however, is impractical except for use as a very modest confectionery, shoemaker's shop, or some such less important but nevertheless serviceable unit.

An economy can be effected by creating a multiple unit, composed of several stores and apartments above the same. This also allows greater variation as to size of store rooms, for when

FIG. 53.—A group store building, Yorkship Village.

properly designed, the space can be subject to many subdivisions, permitting small or large store units as desired. Again, the location of apartments for rent in the second and third stories over stores may present an economical solution for certain problems. The arrangement on Collings Road, Yorkship Village at Camden, N. J., is an illustration. (See Fig. 53.)

In the larger units, the inability to forecast when the apartments will be occupied by those operating the stores requires that they be designed to permit renting, either separately or together. In either case there should be provided a private entrance door and stairs leading to the apartments located on the second floor.

A rear door and service stair should be provided for each apartment and a rear door for each store.

A stairway, which in most cases can be arranged under the stairs leading to apartments, should be provided to allow circulation from store room to a portion of the basement divided off for use as a stock or storage room for the store. In addition, an exterior hatchway stair should be provided for bringing in supplies, and as a means for reaching the basement for the apartment tenant, when the apartment is rented separately. In this case a portion of the basement should be divided off for use as a laundry.

The method of heating the building will depend upon how the building is to be operated. If a janitor is to be employed by the owner, a central heating plant should be provided in a portion of the basement separated from the portions allotted to the various tenants, and the rentals fixed at a figure to cover heating. If a janitor is not to be employed, individual heating units must be provided for each portion of the building subject to a separate rental. The latter method frequently results in serious conflict, and the first cost is large. Therefore, it is suggested that generally, inasmuch as stores and apartments are usually rented together, a single unit heating system be provided for each pair; and, in the event that the storekeeper desires to sublet the apartment, he be obliged to furnish the heat therewith.

Requirements of Store Rooms.—While no exact information can be given, the average size for a retail grocery store, drug store or butcher shop, catering to an ordinary sized suburban trade, is approximately 1,000 to 1,200 sq. ft. in area.

Fixtures, whether furnished by the owner or lessee, should be provided as an item separate and apart from the general contract for the building. Some plan, however, for a general arrangement of such furniture, so as to allow freedom of circulation, should be kept in mind, in order to design the store space intelligently with a view to future service.

The finished floor should be a good grade of rift sawed, yellow pine, tongue and grooved flooring, with an oil finish, laid on a counter base of 8-inch flooring.

A sink with hot and cold running water should be furnished in the store room, and a toilet provided in the cellar.

Show windows of a size and character to satisfactorily display goods should be designed. These will be further considered in a later discussion on exterior appearance of the building.

Posts should be eliminated as far as possible. This may mean arranging store units in suitable widths in order to allow clear spans without use of excessively large beams and girders.

Transoms over doors and windows in exterior walls should be provided to insure ventilation and light. Care should be exercised to prevent the windows interfering with shelving and to insure the best use of wall space for stacking goods.

Electric lighting should be provided, with lights controlled by switch at a panel board. Lights for show windows should be controlled either by local snap switches or by separate controls on the main panel board. A gas pilot light should be arranged for use in emergency cases and for burning at night.

Requirements of Apartments.—General minimum requirements listed for similar types under general housing apply with equal force to apartments.

Buildings, in which the apartments partake of the nature of duplex apartments, should not be over two stories in height unless permitted otherwise by ordinance. They need not be fireproof, except where the store room is used as a garage, in which case that particular portion of the building must be entirely fireproof.

In store buildings of three stories the apartments should be subject to fire protection, insofar as enclosing stairs and stair halls with masonry walls and providing fire escapes suitably located so as to serve each apartment.

Exterior Appearance.—The feature of exterior appearance which will need careful handling to avoid a feeling of commercialism and lack of refinement, is the show window. To make store buildings harmonize in design with the rest of the development, best results can be obtained by arranging the show windows in the form of square or octagonal bays. This treatment lends an impression of domesticity and offers several points of practical advantage.

First, in order to further the interest of general harmony in the placing of the building with relation to neighboring dwellings, this permits the projecting of bays which would not be possible in city stores built close to the sidewalk line.

Second, in many stores a screen, dwarf partition may be placed across the bay opening, on a line with the main building wall. This serves as a vertical plane to back up the display and at the same time makes the problem of heating easier, as it partly takes care of the large glass exposure.

In stores which require heavy deliveries of goods, facilities for handling the merchandise should be so arranged that ease of access for delivery trucks will be obtained and also that such features will be seen as little as possible.

SPECIAL SERVICE BUILDINGS

In addition to stores it will often be found necessary to include in the development other service buildings, in order to supply the needs of the community, such as laundry, refrigerating plant and bakery. The service rendered by these units does not make it necessary to intrude them as integral parts of the housing scheme. In fact they should be segregated as much as possible, as they are not likely to prove attractive to the residential districts.

Combined Building.—If the operation of these units is to be conducted by the industry sponsoring the development, or even by private enterprise, in such a manner that they could all be provided for in one building, considerable economy would result. This would not only be true in building cost, but also in operation, as less help would be employed and the delivery feature would be simplified.

To illustrate further the economy which could be realized by housing all these service features in one building, a type of building for the purpose is herewith suggested. The building would consist of a two story structure and basement, the first floor to be of sufficient height above grade to allow ample opportunity for lighting and thoroughly ventilating the basement in which would be located the laundry. A portion of the first floor would be used as garage space, being so designed as to come approximately at grade level. The remainder of the first floor would be used as a refrigerating plant, general office and a room for use as a shop and supply room, in connection with the garage. The second floor would be used as the bakery. An elevator, of sufficient capacity to serve for both laundry and bakery, should be included in the design, so located as not only to serve both these units but also to open directly on the shipping platform.

By this arrangement, economy from multiple units would obtain and, in addition, one garage space with shop and supply room, as well as one heating system and power plant, only, would be necessary; whereas those features would have to exist in each building if arranged in separate units. Naturally the features

enumerated when occurring in the multiple unit would be larger than in each of the separate units, but they would be far less expensive so combined than as three separate units.

The building as outlined above should be of fireproof construction, with a floor load of three hundred pounds for the first floor and one hundred and fifty pounds for the second floor. The roof might be of regular wood construction, either pitched or flat as desired, providing in either case sufficient roof air space is obtained.

In the event of the units being built either as separate buildings or as a multiple unit, the requirements as to capacity and equipment would be the same. In order to give an idea as to what would be necessary in this respect, the following information is given.

Laundry Capacity.—The size of laundry required will depend not so much upon the number of houses as upon the class of the people to be served and the number of persons housed in boarding houses. In addition to these requirements, work to be done for the offices and workrooms of the factory, when such are located close at hand, must be fully estimated.

We will assume an hypothetical case of a laundry, capable of turning out a certain amount of work per day, and on this basis give a list of the equipment required and the size of the building which will be necessary to accommodate such equipment. For the purpose of this illustration, take a laundry of such capacity as to be able to turn out approximately 1600 lb. of laundered goods per day of eight hours. The average weights of various articles is presented in order to give an idea as to what the proposed capacity would mean when translated into number of things to be laundered:

Man's shirt, one pound; underwear (summer), 1/4 lb.; (winter) 1 1/2 lb. Woman's shirt waist, 1/4 lb.; muslin petticoat, 1/2 lb. Double bed sheet, 2 lb. Bath towel, 1/2 lb.; face towel, 1/4 lb.; small hand towel, 1/8 lb. Bed spread, 4 lb. Handkerchiefs, 1/4 lb. per dozen. Collars, 3/4 lb. per dozen. Table Cloth, 2 lb. Napkin, 1/8 lb.

In a family of two parents and two children, the average washing is about 30 lb. per week, and since the proposed laundry could handle 9,600 lb. in six working days, 320 families could be served.

Such a laundry, to be properly balanced in its mechanical equipment, should include the following machines:—

Two Washers, 36 in. by 54 in.—2.0 H.P.	Two Electric Irons and Special Boards
One Extractor, 30 in.—5.0 H.P.	One Soap Tank
One Flat Work Ironer 100 in.—0.3 H.P.	Two Metal Truck Tubs.
One Dry Tumbler 30 in. by 42 in.—1.5 H.P.	

A minimum area of about 560 sq. ft., is necessary to house this equipment. When smaller plants are desired, the best policy is to arrange the machines in any combination desired and operate them as a group or unit by one motor. Such group units are made up and carried in stock by leading manufacturers of laundry equipment. All the machines should be motor driven. High pressure steam should be run to the washers, flat work ironer and dry tumbler; but, if necessary, heating by gas or electricity may be substituted. In addition to the laundry proper, a room in connection with the same should be planned to be used as a sorting and marking room.

Bakery Arrangement.—The size of the bakery, like the laundry, depends upon local conditions of demand, and these offer such a wide variation that, here again, the discussion must center around an hypothetical illustration. However, before going into a special case, a list of articles of equipment for any bakery will be suggested.

The list should include the following:

An oven, preferably a portable type made of sheet steel, as this is less cumbersome, more easily installed and requires no special provisions in the way of foundation or general building construction than an ordinary kitchen range.

In connection with the oven there should be a proof oven for raising the dough preliminary to the baking.

A combination piece of equipment, in which will be found a flour bin, elevator, flour sifter, dough mixer and cake mixer, operated as a unit by electric current, will be both economical and efficient.

A small stove should be furnished for cooking boiled custards, icings and for the mixing of various ingredients requiring heating.

There should also be suitable cases for keeping utensils and general supplies.

A refrigator, in close connection with the bakery, will be necessary.

A sink with hot and cold running water and a number of work tables used in the preparation of the bakery products should be located conveniently to both mixing machine and oven. One of such table should be fitted with pan rack.

The installation of an ice cream freezer, ice crusher and also an ice cream cabinet, connected to the refrigeration plant in the case of the

combined service building is suggested as a desirable feature, although one which is not absolutely necessary.

Assuming the case of a bakery, equipped with a three deck oven, with an area of 74 in. × 92 in., and the other apparatus of such a size as to make a well balanced unit, the capacity may be figured as follows: Considering the making of bread alone, it will be found that the oven above specified can bake 310 loaves at one time and, allowing one hour for a baking and 8 hours for a day's run, the output for a day would be 2,480 loaves. This computation is merely to give an idea as to the capacity of the oven and not as a program for its operation, as a part of the time the oven would be in use for baking pies, cakes or other products.

In order to house this equipment in a suitable manner, a room with a minimum area of 600 sq. ft. would be required. In addition to the bakery proper, a general store room would be required for keeping a good stock of supplies, and a storage space for stacking the bakery products preparatory to delivery.

Refrigerating Plant.—The suggestions offered concerning the ice plant will be based upon an equipment with a capacity of 6,000 lb. a day in standard blocks, weighing 300 lb. each. The apparatus for manufacturing ice herein described is assumed to be of the usual type, operating on the principle of the evaporation of a more or less volatile liquid, this being maintained by a vapor compression machine. The principal parts are a refrigerator or evaporator, a compression pump, and a condenser. The condenser, compression machine, motor, centrifugal pump, dehydrators, air receivers, air pump and filters are located adjacent to the ice making tank or refrigerator. In the case where such tank occurs on the first floor, the refrigerating machinery may be located directly under it in the basement.

The size of receptacle required for the ice making tank, figured to the outside of the insulation, should be about 10 ft. 10 in., by 11 ft. 2 in., by 4 ft. 8 in. in depth. This sized tank holds twenty cans, each yielding a 300-lb. cake of ice. A freezing requires about eighteen hours, the daily capacity can be figured at 6000 pounds. In event the tank is constructed with space under it, the floor should be waterproofed with great care. A water tank should be located in close connection with the ice-making tank, and on the same level as the refrigerator. The water, which has been partially cooled, is run from the tank into the cans, which serve as moulds for making the cakes of ice.

A light type of traveling crane should be installed for lifting the cans out of the refrigerator after the ice has been made. They are then run down to a platform at the end of the refrigerator and deposited on a specially designed ice chute. Hot water is poured on the can and the ice, after melting slightly, is released and slides down the chute through a door, which automatically opens under pressure of the ice block and closes after the ice has entered the storage room. The platform for handling the ice must be well waterproofed and provided with a drain, as much dripping of water occurs.

The ice storage room should be insulated with cork throughout floors, walls and ceiling. The door that admits the ice from the ice handling room should be of special design just large enough to allow the ice to pass through. The door from the ice storage space to shipping platform should be also of special design and should follow the character of doors used in large refrigerators. The ice handling room should be about 8 ft. 6 in. by 11 ft. 6 in., and the ice storage room large enough to permit the keeping of a surplus stock of at least 12,000 pounds.

Hospital.—Medical service is one of the needs which cannot be left to work itself out. Since in many cases the inducements offered for such service, in compensation and living conditions, especially in the smaller developments, are not sufficiently attractive, community action will be necessary to insure the benefits of competent medical attention. This, in its simplest form, should result in the establishment of a dispensary in charge of a resident physician, and in the employment of a visiting nurse.

This first modest measure for safeguarding the general health may be all that the situation demands. Many developments will not require the establishment of a general hospital, for the reason that they are either close to a larger community in which hospitals exist, or because they are close to an industrial plant in which an emergency hospital is maintained. There will be found, however, many isolated industrial developments where the provision of a hospital will be an absolute necessity. Even where, for the present, they have been considered as not altogether essential, it is probable that the growing demand for general dispensary service will eventually result in the establishment of such a unit.

There are many advantages to be obtained by incorporating such units as a part of the general plan. Not only can better

treatment be given the sick, but also there is available the immeasurable service of good nursing, which is quite impossible in many crowded private dwellings. The hospital serves further as a barrier against the spread of contagious diseases and as an almost indispensable help in time of such need.

In order that it may not be an undue economic burden to the community or to the company operating the development, the hospital should be designed so that a portion, only, need be built at first, and enlarged to keep pace with the general growth of the community. Moreover, the design should be studied so that the building at any stage of its development should look finished, and at the same time have the building appear, when complete, as though it had been built all at one time. As such design occupies a special field of its own, this is not the place to express details. It may be suggested, however, that this may be done by employing a plan in which a central portion acts as a key for the complete building. The future additions will become radiating wings connected to the central structure, thus making it possible to segregate any portion as occasion demands.

BUILDINGS FOR SOCIAL NEEDS

Churches.—The diverse character of structures required by different denominations and creeds makes suggestions on the subject of churches difficult. While the desire for such buildings by the people will no doubt necessitate their ultimate provision, greater satisfaction will be obtained by permitting the people themselves to determine the character of these buildings. Whatever the expressed tendency of the people may be as to the kind of church preferred, the design should be as informal as is possible to maintain a churchly feeling and expression.

In the large developments it will often be necessary to provide two or more such edifices to meet the demands of varying forms of worship. The seating capacity and facilities will depend largely upon the denomination, population and the desires of the people.

School Houses.—The necessity for school buildings in an industrial development may be due either to complete isolation from already established institutions, or to lack of accommodations in existing public school buildings, which makes it impossible to take care of the sudden influx of population.

While a great amount of study and care has been given to the large city schools, the problem of the small school has been neg-

lected. The result has been that either buildings of the most primitive character have been provided, or when the demand for something more than the "little country school" prevailed, pretentious imitations of city schools have been resorted to. These, like most imitations, have generally failed of being satisfactory, because in the endeavor to gain a semblance not justified, the more important considerations of economy and appropriateness have been for the most part ignored.

Urban and rural developments require school buildings of different character. In the former, high land values demand that less property be used for this purpose than may be allowed in the rural development. The result will be that the architectural character of the building thus obtained will harmonize better with the general housing; which, following the same line of reasoning, runs more to the larger multiple unit in the urban than in the rural community. This should not be interpreted to mean the building of a small imitation city school for the particular use of an urban development, but should rather result in the building of a real city school by coöperating with the officers of the community at large, and making it an extension of the regular public school administration. This action narrows the problems of the school house to such an extent that its consideration here would only be necessary for the rural districts.

For these districts, the "Pavilion Type School" offers so many advantages, that it would appear to be the logical type to use. This school building is a one story structure, built in units, the general plan of which may be subject to any treatment desired. It is particularly adaptable to rural districts, in that it provides accommodations only as they are needed; and as each addition is in the form of a complete architectural unit, the project at all times gives the appearance of a completed plan. The rather extravagant use of property is justifiable in view of the low property costs.

Some of the more important advantages obtained by the use of this type are as follows:

1. Architectural harmony with the general housing is possible, because the design of the small units can be maintained in style with the smaller detached house unit, which is the logical house type for this kind of a development.

2. The units, being one story structures of moderate size and semi-detached, are readily provided with ample light and ventilation.

3. The fire hazard is reduced to a minimum and no expensive provisions for fire protection are necessary; moreover, the most economical methods of construction may be employed.

4. The covered passageways between classroom units may serve as outdoor classrooms under favorable weather conditions.

5. The initial structure need not make provision for facilities which will be necessary with future growth, but which are not needed at the inception of the town.

Theatres.—The moving picture theatre presents one of the most common forms of entertainment for an industrial community development. It is an economic factor. *First*, the building itself, differs from the regular theatre in that it needs no complicated stage with equipment, and is inexpensive in construction. *Second*, the low admission price puts it within the reach of the lowest paid worker. *Third*, the length of time consumed in presenting one complete performance makes possible two or more performances a night and allows a small seating capacity to meet the demand of a large number of people.

The capacity of the theatre will depend upon the size of the community. To arrive at an approximate seating capacity required, it is suggested that seats be provided to accommodate every evening one person from each family and one person out of every four single workers.

Considering exterior appearance, again it is suggested that the intent of the general development in the observance of architectural style be followed.

Whether building codes or ordinances govern its construction or not, the theatre should include the provisions that are generally accepted as proper safeguards in case of fire or panic. Most important among such recommendations will be the provision of fire exits marked with suitable guiding signs and lights, and fitted with doors to swing out, giving access to outside fire escapes or areas open to the street. These exits should exist on two sides of the building, in addition to the main front entrance.

Community House.—There are a number of general community activities which may be provided for separately or together under one general management. Such general community features as recreation fields, play grounds, assembly halls, day nurseries, club houses and gymnasia, must finally be provided in a well balanced, healthy community. Whether they shall be a part of the general predetermined scheme or whether thay shall result as a spontaneous expression on the part of the people is a matter

of policy to be determined by the promoters of the development. If the latter policy is observed, nothing need be suggested here, except to provide a place and an appropriate setting in the general plan, as the desires of the particular people concerned will become manifest as the idea develops.

However, some modest provision for service of this kind should be made, as a stimulus to community life. With this end in view, which shall be so limited as to leave opportunity for freedom by the people in the pursuit of their social activities, a general community house is suggested.

The house should provide suitable space for the following elements of service:

1. A day nursery.
2. A gymnasium (separate wash rooms and showers for sexes).
3. A kindergarten.
4. Four or five classrooms.

If circumstances require, these additional features may be added:

5. A bathroom in connection with nursery.
6. Two club rooms.
7. A general assembly room.
8. A general dining room.
9. A kitchen.
10. A diet kitchen in connection with nursery.
11. Quarters for the matron and help.

In addition, a playground should be provided.

A building so constituted would permit working mothers to leave their children, secure in the knowledge that they would be well cared for. Such children as were of an age to attend the regular school could not only go to the community house for luncheon, but after school return to enjoy the privileges of the playground, or the gymnasium in inclement weather.

Sewing classes for women and girls and general courses of study for adults could be offered at night, as well as the privilege of using the gymnasium and club rooms. The assembly hall could serve for a general meeting place, for holding of dances, giving general lectures and many other forms of entertainment. In a word, the community house would bespeak welfare work, and by having the various community activities under one general management and in one building, reduce the operation and building costs and maintenance to a minimum.

CHAPTER XII

ADMINISTRATION AND SUPERVISION OF CONSTRUCTION

Organization and Planning—Contract and Specifications—Supervision of Construction

ORGANIZATION AND PLANNING

Character and Scope.—In the development of an industrial housing project the effective organization and wise direction of a competent and experienced personnel is a prime requisite to success, if the result is to be judged on the basis of economy, attractiveness, saleability and good living conditions. To a large extent satisfactory results will depend, first, upon the selection of fully competent and experienced services, and second, upon the laying down of carefully considered and coördinated, organization, planning and construction policies. The expert services of the engineer, the town planner, the architect, the realtor and the constructor:—all are required. And the several problems falling within the province of each are to be solved, so that the solutions may be not only technically correct, but also economically sound, and so that the way each thing is done may bear the proper relation to the scheme as a whole.

Group Management.—The building of a housing project can neither be considered as wholly an architectural nor an engineering problem, but rather as a merging of opinions and talents of each profession into a consistent conception. As there are a multitude of elements which enter into the final plan, the factors of control and coördination become most important, and it is therefore necessary to work out a practical form of organization and to formulate the policies of procedure in accordance with which the work shall proceed.

Executive Control.—A close contact between the owner and the organization provided to manage and supervise the development is essential. This can best be accomplished by the designation of an official by the owner, upon whom the necessary

authority is conferred to fix policies, to make decisions, to execute contracts, to expend funds and to exercise similar important functions. The direction of the work and the immediate control of the housing organization should be centralized in an executive, who possesses the necessary qualifications of leadership and who has had the necessary experience in directing the planning and construction of large projects. Special training in directing the design and in technical details will be most helpful, providing the man also has business experience and executive ability.

Organization Chart.—The details of the organization for planning and supervising the operation, as indicated in the suggested chart (see Fig. 54), will depend upon the extent and character of the work to be handled. Modifications in the initial form of organization will necessarily be made from time to time as the work proceeds. The services for some will be merely of an advisory nature; for others, they will be required during part or all of the work. The administrative department, with a force of employees and assistants, varied to suit the requirements, will be needed throughout the life of the organization; while the greater part of those engaged upon the surveys, designs and plans can be dispensed with upon their completion, except for those necessarily retained to direct construction.

The construction department may not be organized until active construction work is about to begin. When the scope of the work is relatively small, the size of the organization may be accordingly reduced and simplified, by consolidation of duties and functions. Large projects will require a greater subdivision than that assumed in the typical organization chart. The general object to be sought in starting an organization, is such a division and delegation of responsibility and authority, under proper control, as will enable each employee to handle definite duties and functions, with a clear understanding of the measure and limits of his authority.

Method of Procedure.—The controlling features, requirements and policies should be laid down at the outset and a program of procedure in preliminary form should then be adopted. The earlier the method of procedure is decided upon, the less likelihood there will be of incurring delays and costly mistakes. The object of working out a well considered plan of procedure is to assure the orderly and economic prosecution of the work and various stages, and to avoid loss of effort, duplication and

conflict in authority. Such a plan may be considered as analogous to a routing plan in a manufacturing process; beginning with

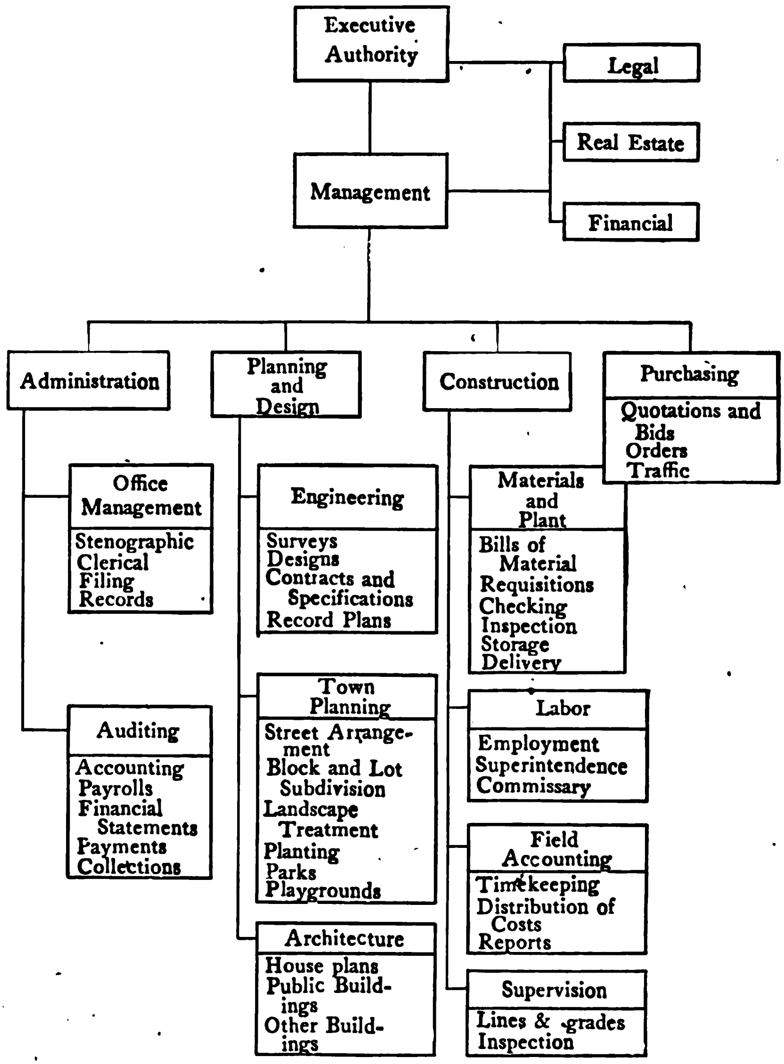

FIG. 54.—Organization chart indicating form of organisation for the planning and supervision of an important industrial housing project.

the making of the designs and working drawings, then passing from department to department and from shop to shop; all in accordance with a carefully prearranged scheme, the finished

article finally emerges a completed product, conforming in all respects to the requirements.

Elements of Program.—The ordinary procedure, after first having ascertained the general need of housing, is about as follows:

(*a*) Determination of housing requirements, as to the number—general type and allowable cost of houses; the method of disposition—as to whether the houses will be rented or sold, or held by a copartnership company, or by a combination of methods; determination of the approximate amount that can be expended upon the development of the site and in providing street improvements and utilities.

The foregoing constitutes a general survey of the situation and leads to definite conclusions as to the housing requirements, the best method of providing housing and the approximate, or the allowable, cost thereof.

(*b*) Investigation of available sites, suitable for the number and type of houses determined upon as a result of the previous study; this involves consideration of the relative advantages and costs of development of alternative sites; requiring comparisons between costs of land, of preparation of the sites, and of building complete developments.

(*c*) Acquisition of site, including examination of title, property survey, preparation of map, and purchase.

(*d*) Topographical surveys and detail map; preliminary study of the town plan and of lot subdivision; studies of types of houses, including development of preliminary sketches, floor plans and elevations and schedules of estimated cost, based upon local data; development of preliminary plans for lot grading, street improvements and utilities, to a sufficient extent to determine the general character and approximate cost; preparation of preliminary budget, based upon the information and data developed in the foregoing studies.

(*e*) Review, criticism and revision of the preliminary plans and estimates, leading up to the adoption and approval of definite general plans; estimates of the cost of the several parts of the work and the preparation of a definite budget of cost.

(*f*) Preparation of detailed construction and working drawings, together with construction specifications; filing and recording plans with proper authorities; arrangements with public utility companies.

(*g*) Award of contracts: including invitation to bidders, receiving and comparison of bids, award and execution of contracts.

(*h*) Construction program, records of progress, accounting, and supervision and inspection of work.

(*i*) Preparation of record plans and drawings.

Necessity for Budget.—The preparation of a budget, hereinbefore referred to in discussing procedure, is necessary; both as a guide and criterion to follow, in working out the plans and designs for the development, and also as a means of financial control of construction. Complete data must be at hand in order that those in executive charge shall have full knowledge as to the ultimate cost to be incurred, and as to the expense and advisability of changes, and so that decisions may be based at all times upon careful analyses of facts.

The budget should be based upon carefully prepared detailed estimates of the cost of the various items of work, and should be conveniently summarized by grouping into main items. The preliminary budget will necessarily be based on approximate information, and, therefore, should be an approximate distribution or apportionment of a certain limiting expenditure per lot or per house. After the site has been selected and the definite plans developed, the final budget may be prepared, and where the cost of any part of the work exceeds the amount allotted to it, the necessary modifications in the plans can then be made.

Analysis of the budget from time to time will indicate the advisability of increasing the allotments for some and decreasing those for other portions of the work, so that modifications in the apportionment of the expenditure, but not necessarily in the sum total, may conveniently be made from time to time. The necessary degree of flexibility must be provided in the budget, to take care of variations in the labor and materials market and in business conditions. This is provided for by allowing a contingent expense of from 10 to 15 per cent.

Suggested Contents.—The following is a suggested form of budget for general use in the development of an isolated housing project. Certain items, such as the installation of water, gas or electric service, if supplied by and at the cost of a public utility company, would not be included, except to the extent that the builders or owners may pay in annual service charges:

1. *Cost of Land.*—Including legal services, recording, property survey and purchase cost.
2. *General Site Improvements.*—Clearing, general site grading, etc.
3. *Houses.*—Listed by number and type.
4. *Buildings other than Houses.*—Including stores, community and public buildings, schools, churches, etc.
5. *Lot Improvements.*—Including grading, seeding, sodding and planting; fences, housewalks.

6. *Street Improvements.*—Grading; curbs and gutters; pavements; sidewalks; seeding, sodding and planting in planting strips and other open spaces on streets; catch basins and inlets, including connections.

7. *Parks and Playgrounds.*—Boulevards and parkways, including grading, construction and adornment.

8. *Water Supply and Distribution.*—Supply, including pumping stations, reservoirs, supply mains, filter plants, etc.; distribution system.

8*a*. *House Services.*—House to curb and curb to main, may be separated in jurisdiction and chargeability.

9. *Sewerage and Sewage Disposal.*—Collection system; outfalls; sewage disposal plant.

9*a*. *House Connections.*—(Excluding any portion included in house contract.)

10. *Storm Water Drainage System.*—Collection system, main drains, etc.

10*a*. *House Connections.*—(Excluding any portion included in house contract.)

11. *Central Heating Plant.*—Supply, distribution and house connections.

12. *Refuse Disposal.*—Incinerators or other disposal equipment.

13. *Gas Supply and Distribution.*—Supply, distribution system and house connections.

14. *Electric Supply and Distribution.*—Supply, distribution system and house connections.

15. *Street Lighting.*—Supply, circuits, poles, lamps, etc.

16. *General Overhead.*—Including professional services, engineering, architectural and town planning; administrative, financial management and general expenses during organization and construction; contractors' profit and all charges which cannot be charged to any of the foregoing items, and for which a separate charge is not set up.

Where the work is done directly by the owner, or under some of the forms of cost plus contracts, it may be desirable to set up separate charges for such items as railroad siding and yards, temporary storage yards, and other general items of construction; otherwise, where not so charged, these costs are distributed among the various items of the budget.

Construction Policies.—An early decision should be reached as to the policy to be followed in carrying on construction, in order that the plans and specifications may be drawn in conformity therewith. In making this decision, a choice must first be made between having the owner do the work directly, or by force account, utilizing his own construction organization, purchasing materials, hiring labor and buying or renting plant; and having

the work done by an independent organization under some form of construction contract.

Force Account.—Construction by force account may be carried on where the owner maintains a permanent construction department with competent personnel, or where an engineering organization, which has demonstrated its capacity for handling work in this manner, is employed. In such cases the owner assumes all of the risks and performs all of the functions which would be divided between himself and the contractor on a contract job. His organization will therefore have to be practically as large as the combined organizations of owner and contractor, and under ordinary circumstances no advantage can be obtained by handling the work in this manner, sufficient to offset the superior organization, experience and plant of a reliable and experienced contractor.

On force account work, no contract need be drawn and general specifications need not be so formal, but if satisfactory work is to be assured the plans and technical specifications should be fully as complete as on contract work, in order to guide and instruct those in immediate charge of the various portions of the job. In other respects, the discussion of construction problems below will apply to force account work, with due allowance for the identity of owner and contractor.

Contract.—If the work is to be done by contract, various forms of contract are to be considered, each having particular advantages and disadvantages. The essential differences between them are in the method of payment and in the degree of risk and financial responsibility assumed by the contractor. The principal forms and their chief characteristics are as follows:

Lump Sum Contract.—In this form of contract the contractor furnishes all labor, tools and materials and executes the work complete; accepts all risks, and receives in payment therefor a stipulated lump sum amount, which includes all of his costs and profits. The contract, drawings and specifications must be in unusually complete detail, if this form of contract is to be entered into, in order that the contractor may be fully informed and estimate the cost of the work, and to obviate subsequent controversies.

Unit Price Contracts.—Similar to the foregoing, except that payment is made on the basis of prices bid per unit of measurement, which may be per cubic yard, per lineal foot, per pound, or other unit.

Cost Plus a Fee Contract.—Under this form the contractor executes the work in conformity with the plans and specifications, charges the

full cost of labor, tools and materials to the owner, and receives in payment for services and for furnishing supervision and plant a fixed fee. Some forms of contract provide for a sliding scale fee which increases or decreases in inverse proportion to the cost of the work, within certain stipulated limits.

Cost Plus a Percentage Contract.—This is somewhat similar to the preceding form, except that the contractor receives as profit and compensation, a stipulated percentage of the actual cost of the work. The percentage may be fixed or may decrease or increase inversely with the cost of the work.

The chief advantage of the lump sum form of contract is that the cost of the work included is definitely fixed by the contract price agreed upon. With a stable market for labor and materials and for work of relatively small amount, the fixed price form of contract, or its companion the unit price contract, has many advantages; but under such conditions as have existed during and subsequent to the Great War, there has been a general disinclination on the part of many contracting firms to enter into this form of contract. There are many elements, such as the cost and supply of labor and materials, car shortage, and other factors, which are beyond control and which constitute an abnormal degree of risk and possible financial loss. Contractors are, therefore, unwilling to enter into this form of contract, unless a very large allowance is made in the bid to take care of the risk involved.

Where the amount of the contract is relatively small, the element of risk on account of the foregoing factors is not so material, and it is therefore often possible, even though the greater part of the work is executed under a different form of contract, to do certain parts, such as grading or the installation of sewers or other utilities, under the unit price contract. And it is further the practice of contractors, in taking large contracts on a cost-plus basis, to have certain parts of the work done by subcontractors at lump sum or unit prices. In order to provide for this, contracts on a cost-plus basis may stipulate that certain parts of the work may be, upon approval of the owner, sublet by the general contractor.

Assuming that the contractor is fully competent, and experienced and that he has adequate plant, capital and organization, and is in every respect dependable and reliable, there is, under present day conditions, a general feeling that the cost-plus form

of contract, or some of its modifications, will give better results and be more equitable to both parties than the lump sum or unit price contract. In this form of contract, the owner pays the actual cost of the work, plus a reasonable profit to the contractor for his services.

The cost-plus form of contract is more difficult to administer and supervise than others, and the success of the undertaking will, to a certain extent, be dependent upon the degree of confidence existing between the parties. While the contract, in general, provides that any losses or costs, due to the negligence, incompetence or carelessness of the contractor, shall be charged to and be borne by him, it is difficult to clearly establish responsibility when controversies arise, and it is therefore extremely important that discretion and judgment be exercised in selecting the contractor.

Selection of Contractor.—The selection of the contractor, or contractors, deserves much more consideration than is often given. While a definite legal and binding agreement is absolutely necessary in fairness to both sides, yet the relation must be premised on mutual confidence between the contracting parties. Regardless of the provisions of the contract, either party as a matter of fact may be subject to losses, direct or indirect; so that the highest measure of protection is found in mutual confidence between those entering into the obligation. Proposals should be entertained only from contractors who can furnish full, complete and satisfactory information and assurance as to their experience and ability to perform the work in a satisfactory manner within the stipulated time.

This will involve the consideration of many factors, including: —the extent, experience and ability of the contractor's organization; the working capital and resources; the amount and character of plant and equipment; history and past performances as to satisfactory work and promptness of completion; reputation, credit and character of the contracting company. While it is in general good business policy to take advantage of the lowest price offered, the question of price must be considered as only one of the items and factors which enter into the most advantageous arrangement, and frequently it is one of the lesser items. Adequate and satisfactory service has its market price, and the proposal to do a certain amount of work for considerably less than the price which is reasonably estimated for it, unless based

upon superior organization, equipment or methods, should be viewed with suspicion.

CONTRACT AND SPECIFICATIONS

Purpose of Contract.—The purpose of the contract is to define clearly the scope of the work to be included, and the responsibilities and obligations of the contracting parties; to establish the basis of payment, and to define the extent of the services to be furnished and the work to be done by the contractor. The contract should include the general provisions, or articles of agreement, detail or technical specifications, the contract drawings and plans, and the supplementary or detailed drawings required as the work proceeds and the terms of payment. The conditions and provisions of the contract will necessarily vary with its form and basis, and must further be adjusted to suit each particular locality and condition.

General Provisions.—Particular consideration should be given to the formulation of the following provisions of the contract:

(*a*) A clear and complete statement as to the extent and character of the work, which forms the basis of the contract.

(*b*) A concise statement as to the basis of payment for labor, tools and material, and, in the cost-plus form of contract, a definition of the elements included in the contractor's profit.

(*c*) Stipulation as to time of completion of the work included in the contract, with provision in the unit price or lump sum contract for the payment of liquidated damages by the contractor, in the event of failure to so complete within the stipulated time.

(*d*) Bond, of surety or trust company, to be furnished by the contractor, as a quarantee of faithful performance of the contract and discharge of its obligations.

(*e*) Definition of the contractor's responsibilities and obligations with particular regard to damage to persons or property, and the observance of laws and ordinances.

(*f*) Provision for the doing of additional or extra work, not specifically provided for in the contract or specifications.

(*g*) Alterations or modifications in the contract plans or specifications.

(*h*) Settlement of disputes; should provide a mutually equitable method of settling any disputes or controversies which may arise in the course of the execution of the work.

(*i*) Provision for cancellation of part or all of the contract.

(*j*) Terms of payment to the contractor.

Specifications.—The purpose of specifications is to supplement the contract and the drawings, by giving additional information and instructions as to the materials to be furnished and the manner in which the work is to be done. The specifications further serve the contractor as a guide to the requirements of the work in preparing his bid, and as a manual of instructions to those supervising the work.

Specifications can most conveniently be arranged by grouping the general requirements as to labor and materials and workmanship, which are common to a number of items of work, into general specifications; and then providing detail specifications for the various parts or items into which the requirements of the general specifications are read and which contain, in addition, the provisions applying to the particular items or classes of work. Where the work is on the unit price basis, particular attention must be given to clearly stating the work included in the price bid and the basis of its measurement and payment.

SUPERVISION OF CONSTRUCTION

The extent of the organization to supervise construction will depend upon the extent of the work and the form of contract under which it is to be executed. In any event, the force must be organized to give general supervision, to inspect the materials and workmanship, to give the necessary lines and grades for the construction, and to keep records of progress and for certification of payments. Where the work is done on a cost-plus basis, there must further be provision for financial control, for timekeeping and checking of labor, materials and bills, and, if the materials are to be purchased by the owner, a purchasing department must be included.

It will be necessary that the owner have sufficient control over the work to insure that the contract is carried out in accordance with its terms and that his interests are fully protected. To this end it is necessary and advisable to supervise the construction with the same degree of care as that followed in the preparation ot the plans and designs. A construction superintendent or manager should be placed in immediate charge of the work, and should report directly to the executive officer in general charge.

Construction Problems.—Adequate consideration must be given to a number of problems which arise in construction, both

to see that suitable provisions for their solution are included in the contract and that they are satisfactorily carried out in the field. These include the following:

Program.—A program of the order in which construction is to be carried out should be devised at the inception of the work. This will provide for the rate and sequence of the various operations, enable materials to be ordered and distributed without delay and confusion, and prevent the interference of one part of the work with other parts. The details of the program will depend upon the size of the undertaking, and the extent to which plant and equipment can be used and the number and size of labor gangs which can be advantageously and economically employed. Serious delays, loss of time and excessive cost may be incurred by pushing one class of work ahead, to the detriment of the work as a whole. It may not always be possible to adopt the most economical plan of operation, as the demand for speed may be greater than that for economy; but there will be, in every undertaking, a program for any desired rate of progress which will be most economical, and if the time element is to be materially decreased, it can only be accomplished by undergoing excessive construction cost.

If construction economy and demand for early completion of the houses were left out of consideration, the most desirable plan would be to first execute the general grading of the site and complete the street improvements and utilities and thereafter build the houses, but it is ordinarily not feasible to follow this plan, as it will generally require two working seasons. It will therefore usually be necessary to make reasonable provision for temporary construction roads and to proceed with the construction of houses, after the rough grading has been done, in one part of the tract, while street improvements and utilities are carried along in another part. By suitably dividing the work into several sections, a continuous use of various sized gangs of labor and skilled workmen may be worked out, which will not only produce more satisfactory labor conditions, but will expedite and reduce the cost of the work.

Yards and Delivery of Materials.—The expense of handling materials, in unloading, hauling, storing and delivering is an important item in the cost of construction. Where the size of the work warrants, it will be advisable to extend a siding to and into the tract, provided the cost is not excessive compared

with that of unloading and trucking from an existing siding. This siding should be extended in such manner as to enable a storage and unloading yard to be developed in a location which will be convenient for the delivery of materials by trucks to the various parts of the tract. Certain of the building materials may be unloaded from the cars directly into trucks, and immediately distributed on the work; other materials, such as cement, lime, etc. must be placed in temporary storage buildings for protection from the elements, and hauled to the work as required.

Sanitation.—Unless the project is a small one, and particularly when the site is remote from built-up districts, the construction of contractors' camps will be required. Such camps will be of temporary construction and will include bunk houses for the laborers, quarters for the superintendents, office men and foremen, a commissary, stables, store houses, blacksmith shop and other buildings and facilities including perhaps a first aid station, or emergency hospital.

The site for the camp and the location of the various buildings should be carefully planned with respect to utility, health, sanitation and convenience.

The sanitation of the contractor's camp surroundings and food supply cannot be neglected without running a grave risk of having infectious diseases break out and spread. This will not only delay the work but may create a prejudice which will react against the success of the project. Attention must be given to the housing of the workmen, requiring that the quarters shall be livable and satisfactory with regard to ventilation, cleanliness, and space allowed per man. Satisfactory sanitary standards should be observed in regard to the collection and disposal of garbage and other wastes, and adequate sanitary facilities must be provided. Not only do these things concern the immediate question of health, but they also exert a great influence upon the spirit and efficiency of the workmen.

Fire Protection.—Fire protection becomes a very important feature in the construction of a large number of houses in isolated districts beyond the service of established fire departments. It will frequently be necessary in such cases to provide temporary means of fire protection until the installation of the water supply distribution system has been completed and permanent fire fighting equipment has been provided and its personnel organ-

ized. Such temporary fire protection measures will include the designation of one of the construction men as fire chief, with a sufficient force of men readily available from the construction forces. Fire signals for giving the alarm must be provided and occasional drills held in order to familiarize the men with the facilities and equipment and the methods to be followed. The equipment should consist of an ample number of barrels of water, with buckets suitably marked at each building, and a supply of chemical fire extinguishers located at specified points. A good system of fire prevention, well managed and directed, and a strictly enforced set of regulations, with systematic inspection of the premises, will be effective, unless conflagrations are started under unusual circumstances. An important provision in the fire regulations should pertain to the location and isolation of buildings containing inflammable or combustible materials.

Where the future fire protection service will not be rendered as an extension of an existing municipal service, the permanent fire protection service should be planned at the beginning of construction, and any equipment which can afterwards be used as part of the permanent equipment should be promptly purchased and put into service. In any case where the size of the project warrants, chemical fire fighting equipment or hydrants and hose, served by a temporary water supply, should be provided.

Temporary Water Supply.—The permanent water supply distribution system should be planned and constructed, so as to minimize as much as possible the extent and cost of temporary water supplies for construction and fire protection purposes. Pending the installation of the permanent lines, it will be necessary to lay temporary water lines, which will usually consist of 2-in. screw joint pipe, laid directly on the surface of the ground, with suitable covering at road crossings. Proper consideration must be given to the source of this supply, and provison made for the constant supervision and protection of its sanitary quality, if necessary, by the use of disinfection or filtration. Careful study should also be given to the layout of the temporary water distribution system, so that it may conform to the requirements of fire protection, and be as useful as possible in connection with the permanent system.

Construction Roads.—The extent to which construction roads must be built will depend upon the size of the project and the

character of the soil. Where possible, temporary construction roads should not be built until the streets have been rough-graded, and consideration should be given to whether economies may not be realized by utilizing the graded permanent streets and alleys for the location of construction roads.

The extensive use of modern heavy trucks has made the requirements of temporary construction roads more severe than was the case a few years ago; the trucks are operated at a much higher cost per hour than in the case of horse drawn wagons. It is therefore possible and necessary to provide a road surface of sufficient wearing and bearing qualities to permit the efficient operation of such heavy vehicles. Cinders, local gravel or broken stone can be used for surfacing; heavy planks or corduroy are frequently suitable for such temporary roads.

Progress and Cost Reports.—An important function of the construction organization is to compile information for and prepare reports as to the progress and cost of the work. A progress chart, covering the details as to the time of starting and completion of each part of the work, is of great value in the management of construction. Unavoidable delays and conditions will undoubtedly cause modifications in the original program and its enforcement can be accomplished only by periodic reports as to the progress actually made on each part of the work. In this way, delays affecting any part of the work, with the possibilities of interference and confusion, will be detected, and steps may be taken for the rectification of conditions.

Cost accounting and cost reports will constitute one of the most difficult items of administration of construction. These will require the formulation of a simple but effective method of obtaining the cost of labor and materials and their distribution among the various items of work. The accounting work should be placed in direct charge of an official whose experience and qualifications include both those of construction accounting and the practical direction of construction work. The ordinary accounting methods are entirely unsuitable for the purpose in hand. Where the work is being done under a cost-plus form of contract, it is absolutely necessary that those in executive charge of the work have at hand at all times the actual cost of each part of the work, for the reason that there is no other method of determining whether or not the work is being carried out at a reasonable cost. In this manner, instances of leakage, waste,

incompetence or improper methods of construction may be detected and corrected.

Record Plans and Reports.—Record plans should be prepared of the development as actually constructed. These will include the plans relating to final street locations, property lines and easements which will be necessary; descriptions required for recording properties and easements, and in dedicating or deeding streets or highways to the municipality.

These record maps should show, in plan and profile, the definite location of the street lines, and the location of monuments and necessary information and should further show the established grade lines. Record maps also show the property subdivision, block and lot records and house locations.

Record plans of the street improvements, utility systems and house services and connections should be prepared which will show location, character and size, in sufficient detail so that the necessary information will be readily available when required in operation.

CHAPTER XIII

MANAGEMENT OF INDUSTRIAL TOWNS

Types of Towns—Isolated Industrial Towns—Suburban Industrial Towns

TYPES OF TOWNS

Company-controlled Towns.—The keynote of this chapter results from the firm conviction that permanently company-owned and exclusively company-controlled towns are theoretically undesirable civic units in the United States; unless situation, isolation and character of industry make such advisable for municipal purposes. They are undesirable, if avoidable, because they are out of place in a country, whose government is one "of the people, by the people, for the people". Should one insist upon a practical demonstration of this truth, it can be found in the historic dismal failures of several so-called model towns—superior as to houses, sanitation, utilities, and similar physical requirements—but in which the management has been falsely founded upon paternalistic rather than democratic principles. Residents of such company towns frequently refer to the irksome and irritating relationships that exist, in spite of all efforts that may be made to make the community conditions happy and agreeable.

The difficulties and dangers which characterize a company-controlled community should be thoroughly appreciated at the outset by the promoters of an industrial enterprise, which involves the provision for housing by the company, at least for a time. A full knowledge of the responsibilities that arise in connection with the management of a town may vitally affect the formulation of a program of industrial expansion. Often it is too late to change the policy after the town or the plant has been constructed. Every effort should therefore be made to solve the industrial and the town problems together, and, if possible, in such a manner as to make a company-controlled community unnecessary or temporary. Nevertheless, there are

many situations where isolated company towns are the only solution.

Isolated Company Towns.—The method of administration applicable to an industrial town is greatly affected by its location. Some industrial towns must necessarily be isolated from existing communities—as, for example, many mining towns. The isolation combined with such factors as high cost of construction, non-fertility of soil, short life of industry and absence of diversified industries, may make the houses non-saleable. In other words, it may be unavoidable and, therefore, desirable that the company maintain the ownership of all the houses, and consequently exercise control over the town affairs. In fact, such a town, including streets, utilities, houses and public buildings, is private property. Some suggestions as to the management of such a town, so as to avoid, so far as possible, all the disadvantages inherent in this condition, will be outlined later.

Suburban Industrial Towns.—Many industrial towns, however, may be built adjacent to or in close proximity to established communities. Because of the residential value of the property, the possibility of annexation to the larger city, and the variety of industries available for employment, the houses may be readily saleable. Thus in due time, the entire management of the town will pass out of the hands of the industry and into the control of the community. The desirability of this situation, as compared with that previously referred to, is apparent. The selection of such a location, when ever possible, cannot be too strongly recommended.

It should be pointed out, however, that even in these conditions there is a transition era, during which the company must manage the town affairs, in order to provide adequate facilities and progressive improvements, which lack of funds and unwise planning frequently prevent in new growing communities. How this can be most judiciously carried out and how the transfer can be most speedily and satisfactorily accomplished is the problem to the solution of which this discussion will be addressed.

Too much stress cannot be placed upon the importance of good management on the part of the company during such a period of transition. The saleability of the houses and success of the whole program are affected by it. For example, if, through negligent public health administration, epidemics break out; if, through faulty upkeep, the houses deteriorate; if, through inade-

quate fire fighting facilities and organization, serious conflagrations break out; if, through lack of proper policing, houses of bad repute become established or lawlessness become rampant; if, through lack of supervision, store prices become extortionate; if, through lack of medical attention, high mortality prevails;—if any one or all of these conditions arise through inefficient or negligent company administration—the sale of the houses will be greatly delayed, and the entire working out of desirable plans and policies may be retarded, if not entirely frustrated.

We may, therefore, conclude that the ideal industrial community is one of permanent character, in localities where values will continue relatively stable; one which has been planned along broad and comprehensive lines, with well directed initial development, but one in which it is possible for either the industry or the individual to build and own houses subject to proper restrictions and regulations. Such happy results will eliminate the paternalistic atmosphere of company control and at the same time prevent the haphazard and undesirable type of development that results from miscellaneous individual operations.

ISOLATED INDUSTRIAL TOWNS

Usually Company Towns.—Isolated industrial towns usually begin as, and have a tendency to remain company-controlled towns. This is neither universally nor necessarily true, as examples could be cited where such towns, originally established by a single enterprise, have nevertheless developed community-control, with coöperative or copartnership management, or under the more usual forms of municipal organization.

Commonly, however, isolated industrial communities remain company-controlled, most frequently because of necessity arising out of the non-saleability of the houses; but occasionally, through choice of the industrial management. Such necessity is a real and valid reason for company control. Conditions may readily be such that the workman would be unwise, to say the least, to invest his savings in a home, the usefulness of which to his family is wholly dependent upon his holding a particular job. Company ownership of houses and all other facilities leads almost unavoidably to company management of the town. But sufficient experience has now been obtained in such questions to justify the conclusion that no broad minded industrial leader

should any longer voluntarily choose permanent company control of a housing development, if it were possible to hope for anything like equal results under any other form of management.

Supposed Advantages.—Formerly it was considered a certain advantage for industries to control the homes of their workers. It was thought that this was the only sure way to have adequate housing; that such control of houses was helpful in case of labor troubles, giving the company an added weapon in the threat of eviction, and permitting shelter to be furnished for those willing to work; that in case of shortage of work or temporary shutdown of the plant, idle workers would not be pressed for rents by avaricious landlords; that town sanitation, cleanliness, secure policing, etc. could be more expeditiously and efficiently handled by the company.

But the old, brutal methods, both of strikers and of their opponents, have gone by the board, to be succeeded by a new spirit of discussion and conciliation. And although it is true that democracy and efficiency do not always go hand in hand, recent history has proved that democracy, even though less efficient, is a safer and wiser aim than the most efficient autocracy. Old considerations, therefore, no longer apply. And, while it is no doubt easier for the company to maintain its control of the management of the town, than to attempt the difficult task of developing in the people the capacity and the organization for self-government, nevertheless the easiest way may prove the most costly way in the long run, and, therefore, the effort toward democracy is worth trying wherever success is possible. Industry is striving today to evolve a new industrial democracy, and no better preparation can be had for the development of methods of organization and for the assumption of new responsibilities than the control by the worker of his own home and his own community.

Unique Conditions.—In the cases where company ownership and control in towns detached from other communities are unavoidable, however, the industrial leaders, upon whom devolves the duty of town management, must have all their conceptions and plans influenced by the fact that conditions are entirely different from those prevailing in the average small independent American city. Many schemes which may work out in the latter may fail in the former, largely as a result of certain of these differences; among which special mention may be made of uni-

versal tenantry, absence of competition between landlords and identity of employer and landlord.

Universal Tenantry.—Company control means that all of the people are tenants or boarders, and all the stability, responsibility and balance that germinate and flourish in a community of home owners are absent. There is a certain magic in home-owning. The individual who secures a deed to a small plot of ground and a little home thereon has his economic and political theories profoundly altered, and no community can afford to overlook the difference between such a citizen and the one who rents or boards, and whose range for theorizing without affecting his immediate interests is correspondingly greater.

One Landlord.—Universal tenantry creates unique reactions, and these are seriously complicated and accentuated in the company town by the fact that all the tenants have the same landlord. Monoply of any necessity engenders distrust of those dependent upon the monopolist, and absence of competition between landlords removes one of the healthiest characteristics of normal independent communities.

Frequently there is no valid reason for distrust, but such feelings are not always dependent upon reason for their development. No matter how equitable the company may be in its dealings, therefore, it cannot afford, in formulating its policies, to neglect the influence of its sole landlordism. And at the same time, it must guard against the mistake of going to the extreme of an over-generous attitude, which may wreck the whole development upon the rock of paternalism.

Identity of Landlord and Employer.—If to these reactions are added those that result from the fact that the monopolistic landlord is likewise the universal employer, then indeed can one realize the multitude of complexities that differentiate the problems of management in a company town from those of normal communities. These unique conditions must necessarily react upon the system of government in all of its manifestations and no program of management can have even a chance of success unless it takes them fully into account at all times.

Principles of Town Management.—If, then, permament company control of towns is not desirable, but if under certain conditions such control is necessary, it becomes important to organize the management so that it will approximate as closely as may be, the conditions found in independent towns. In

solving this problem, two principles will be of greatest help: viz., that the home should be separated from the plant, and that the town should be, as nearly as possible, self-supporting.

Separate from Plant.—One basic principle to be adhered to is to make the town management as independent and separate from plant control as is possible. A step in this direction may be achieved by locating the town a reasonable distance away from the industry, as discussed in Chap. III. Physical separation makes more readily possible the separate organization of the management, as well as of the financing and construction of the town. Subsidiary land companies or housing organizations are often a means of keeping town and plant management separate. Of course, when the proprietorship is traced to the highest officers in authority, the controlling interests will be found identical; but in the current every day affairs this identity need not be obnoxiously manifest.

Certain financial transactions, such as the payment of house rent, or the payment of store bills or boarding house obligations, etc. are often deducted from the pay envelope at the plant cashier's office. This is commonly justified as a measure of security and efficiency, but it does intensify the atmosphere of company control. It might appear like "straining at a gnat"; and yet it is a fact that the actual receipt by the employee of his full earnings, even though they may remain in his possession but a short period before disbursements are made, carries with it a certain feeling of independence and satisfaction. It likewise carries with it a certain responsibility on the part of the wage earner because it indicates that trust is placed in him; whereas the opposite course expresses a lack of confidence that is inimical to good relations.

It is also contrary to the American spirit of independence to relate too closely the conduct of the worker in the home and his standing at the mill, so that one affects the other. There are much better ways of educating the workman who does not keep his premises clean, than by threatening to have him discharged from his job; just as there are better ways of rewarding civic pride than by promotion at the plant. It is easy to see how readily these and similar undesirable interactions take place when town and plant management are too closely merged.

Certain industrial leaders, in an effort to promote the welfare of their employees, have developed elaborate systems of keeping

in close touch with their personal and home affairs. This, of course, is an attempt to develop the old-fashioned intimacy of contact between the owner and craftsmen. Modern industry, however, with its complexity and magnitude, makes this intimacy well nigh impossible. To foster it artifically develops perhaps the husk, but not the heart. For example, if nurses visit the homes of absent workmen to learn the cause of absence—sickness or otherwise—it should be made apparent that this comes from a real interest and desire to be of help and not for the purpose of obtaining truancy reports.

Such illustrations of keeping town and plant separate will be enlarged later in outlining the divisional functions of the department of town management.

Self-Supporting.—Insofar as it is humanly possible the town should be made self-supporting. It is inimical to the best interests of both the company and the workman to have the workman receive something for nothing. In Chap. II attention has been called to a marginal deficit that appears to prevail today with respect to supporting houses for common labor from rentals alone. This anomalous condition is no doubt transitory, due to mal-adjustment, subsequent to the Great War. Higher wages or lower building costs will cause it to vanish in time. It in no way disproves the contention that company-controlled towns, like other self-respecting communities in the United States, should be self-supporting.

A certain industrial town was for a time largely supported from the coffers of the company. Such gratuities as free house rent, free furniture, free light and heat, free telephone service, free repairs, free recreation, etc. were furnished to the employees, the quantity and character of these perquisites being dependent upon the position of the individual with the company. It then became necessary, in order to distribute these gratuities equitably, to prepare a list of regulations, classifying the employees, not only with respect to employment and wages, but also with respect to furniture, recreation, utility service and home life, and adopting standards for each classification.

The difficulties of attempting to standardize homes are apparent. One might as well attempt to standardize noses. The plan has always been a failure. Instead of producing contentment, it arouses dissatisfaction. It is expensive because people often request service, because it is free, in excess of their needs.

The free-for-all plan has largely been abolished and the pay-for what-you-get system substituted, an adjustment being made in salaries and wages and the town made self-supporting. This would seem to have been merely a bookkeeping transaction; in reality it was much more,—it was substituting independence for paternalism.

Functions of Town Management.—In outlining the various functions of town management in a company-controlled industrial town, the two previously mentioned basic principles should be adhered to as far as possible,—namely, town management should be separate from plant management, and the town should be self-supporting.

Public Services.—The department of town management should include, in addition to management of houses, such public services as operation and maintenance of water supply and sewerage; supervision of garbage and waste removal; upkeep of trails, roads and pavements; supervision over domestic gas and electrical service; care of public grounds and parks; and public health and police administration. Consideration has been given to the management of the various public utilities in the several chapters relating to them. Reference is again made to them principally for the purpose of calling attention to certain additional points not there referred to.

It goes without saying that the design and construction of a water system for a town of almost any size should be placed in the hands of experts trained along these lines. There is likewise great advantage in having the operation of the water system placed under the supervision of a trained organization containing engineers, chemists and bacteriologists. For towns too small to justify the maintenance of a complete organization of this kind for the purpose, many companies now render such services under a part time arrangement, whereby the best technical advice can be obtained at a reasonable cost. Sewerage systems and sewage disposal plants, if correctly designed and constructed, may require less technical supervision than do water supplies, but thse also should have skilled direction, in order to promote efficiency and economy.

Garbage and waste removal and disposal require close, systematic watching and inspection, rather than technical supervision; if the town is to be maintained in a wholesome condition. Efficient results can be obtained only by enlisting the support of

every member of the community. A campaign of education locally adapted to the peculiarities of the people concerned, should therefore be promoted. Motion pictures and circular notices, illustrating how flies produce diseases; clean-up campaigns; the enlistment of the interest of school children and Boy Scouts; the offering of prizes for cleanest premises and best gardens,—are all methods which will help make and keep the town clean at not too great a cost.

The economical upkeep of roads and pavements requires first, good design; second, thorough construction; and finally steady, consistent repairs, rather than sporadic splurges. A carefully planned program of maintenance, based upon the old-fashioned theory that "a stitch in time saves nine", is the soundest policy to follow.

In company-controlled towns, where service is not supplied by a public utility company, the operation and maintenance of the gas and electrical services may often be placed to advantage in the hands of the plant engineers. Large industrial plants usually include highly developed electrical and mechanical engineering departments which can readily supply necessary men to keep the gas and electrical systems of the townsite in good order. It is by far the best policy to have all gas and electrical service, as well as water, on a meter basis.

Care of public parks and grounds is an important part of town management. These should be made self-supporting insofar as possible. In independent towns, the taxes cause people to feel that they are supporters of the park system. In company-controlled towns, wherein all the property is owned by the company, some process should be substituted whereby the people can become at least part-supporters of their parks. Often profits from company stores have gone into park improvements. In other places, revenue from athletic contests, rental from concessionaires, collections made at band concerts, etc., may be devoted to upkeep of parks and public grounds. It is the principle of self-suppport, rather than the actual saving involved, that is the important issue.

Public health administration is an important function of town management. Unless the town manager chances to be a trained sanitarian, all public health measures may with advantage emanate from the medical department of the company. There are, however, agencies equipped to give special and technical service

in many of the functions of public health service as a part time basis, similar to that mentioned for utility supervision, so that a high grade of sanitary service may be made available at reasonable cost to small towns.

It should be possible to conduct public health administration, and in fact all of the public services enumerated above, much more efficiently and expeditiously in company-controlled towns than in independent communities. While educational measures should and can almost always be used, arbitrary and authoritative measures must be adopted in a crisis, and such measures can be enforced with less delay in company towns than in independent communities.

Housing.—The duties of the department of town management should include the maintenance, upkeep and assignment of all houses, and of buildings used for public purposes.

The repair and upkeep of a large group of company houses is a trying and expensive task. The town management department should maintain a squad of repair men, consisting of painters, carpenters, masons and plumbers, entirely separate from the plant organization. The number of each will depend upon the number of houses, the type and character of occupants. Improvements should be undertaken in a systematic manner. In some cases the cost of repairs has been minimized by agreeing to return a certain proportion of the rent, providing repairs were kept below a specified cost. In certain company towns the cost of certain repairs has been divided between tenants and company. For example, in painting, the company may furnish the material, providing the tenant furnishes the labor. In the upkeep of houses, as in the maintenance of the roads and pavements, it is decidedly the better policy to keep consistently and steadily up with the repairs, rather than permit the property to become in a run-down condition, with the intention of bringing it up to par at one time.

Some system of house inspection must be inaugurated, in order to be conversant with conditions in the interior. This must be handled tactfully, varying with the character of the tenants. The sanctity of the home must be respected. It would be quite impossible to inaugurate a system of house inspection among the Anglo-Saxon mountaineers of a Kentucky mining camp, because of their cherished traditions of independence; whereas, in other mining camps occupied by Negroes and

Slavs, races more or less accustomed to paternalism, no such difficulties are likely to be encountered. Among unskilled laborers, if prizes are offered to the wives for best kept homes, inspections can be made for the purpose of awarding prizes without danger of objection on the ground of intrusion.

All the difficulties involved in the upkeep and repair of houses are trivial compared with the trials of awarding quarters, particularly if there is a house shortage—an almost proverbial condition in most industrial towns. The assignment of houses should be in accordance with strict regulations. Often this will work hardships, but in the long run it will be better. The order of assigning houses should follow a definite plan, the elements entering into which may well be length of service, classification of duties and salaries. If the industry is organized with distinct classifications, in which salary or wage is generally reflected, the element of pay may be disregarded in the assignment of houses, a very desirable elimination.

Commercial Enterprises.—The department of town management should also supervise all the commercial enterprises in the town. Company stores have earned a bad name and in some states they have been prohibited. They still suffer a handicap from this reputation, although in many modern company stores the prices are very reasonable and character of merchandise satisfactory, the standards being even higher than those which obtain in the neighborhood. Certain companies have gone so far as to run their stores at a loss. This is not fair to competing stores in the vicinity, and is simply another example of apparently giving something for nothing. It would be better to make store prices normal, making up the difference in the wage scale, and to use the earnings of the store to provide additional conveniences in the town, in the selection of which the people might have some voice.

In other words, company towns should be managed, so that all the earnings and gratuities should be definitely and clearly expressed in the daily wage. To give a smaller wage, and then add a number of perquisites, does not really alter the fundamental financial considerations, but it does add infinitely to the confusion of the entire plan. It makes the recipient uncertain of his status. It does not furnish a clear-cut basis for comparison with outside communities. It involves the bookkeeping and often deludes both the employer and employee.

If credit is extended in a company store, the collections should not be made from the pay envelope. This, as previously stated, emphasizes company domination over the private affairs of the employee. If independent stores can extend credit without such guarantee, why cannot company stores do it? The undesirable effect upon the spirits of the residents more than outweighs the so-called efficiency of the system. However, cash payments largely prevail in merchandising, and it would be better that company stores should be no exception.

It is perhaps better, if possible, to have the stores operated on an independent basis. Even though the company owns all the houses, it can sublet the store privilege to an outside agency. The store operations of a large corporation are apt to be less efficient than those of a company operated for retail merchandising, as they often fall to the purchasing department, which is organized for an entirely different kind of business, and the rules and regulations of which may not be sufficiently flexible. If the stores are operated by independent persons, the town manager may exert a powerful influence in insisting upon clean, hygienic conditions, moderate prices and courteous service—more effectively, perhaps, than if the store were directly and completely controlled by the town management department.

It is recognized, however, in some cases greater efficiency, goods at lower prices, cleaner products are more readily obtainable under company control than with several inefficiently and incompetently managed stores. Then again, some classes of labor cannot readily finance themselves for family purchases. Such cases call for careful supervision and management so as to eliminate the objections as far as possible.

Coöperative stores have had much success in England and on the Continent. The basic principle seems sound. Superfluous links in the profit chain are eliminated. They cause people to take a greater interest in store economies, because they become sharers in all benefits derived. While several of the early attempts in this country failed, useful lessons may be learned from them, and there is much promise in the possibility of the successful application of this principle. It would be well worth while for all promoters of industrial towns to searchingly investigate the theory and practice of coöperative stores.

Policing.—The policing of a company town is a task of the most serious responsibility—one that may be handled with little

difficulty for long periods, only to have thrust upon it suddenly duties and opportunities of the gravest importance.

All the police of a company-controlled town should have a legal status, that is, they should be deputized officially by a governing body—either city, county or state. Company police—that is, employees of the company assuming unofficial authority—should not be employed. Inside the plant, company watchmen or guards may be used, but never in the town.

It has been said that efficient deputy sheriffs are born, not made. While this office carries with it no great prestige, in order to fill it ably, a man must be courageous, both physically and morally; he must be absolutely honest, and at the same time fully informed upon all dishonest practices and artifices; and he must display judgment and tact, as many regulations that he enforces are subject to his own interpretation.

The prudent town manager must always have at hand carefully worked out plans as to procedure in case of serious disorders, conflagration or calamity. In dealing with lawless people, nothing is so advantageous as being one move in advance. If the town is isolated, means of communication other than by wire to outside centers must be maintained, as wires are readily cut. Explosives must be stored so that strong guards may be placed readily at all magazines. The water supply must be capable of protection and guarding, as interruption of water service is a very simple way of causing serious disaster and confusion. Facilities for accommodating police reinforcements should be available. Crises may occur which will require the presence of a corps of state police or militia, and if living quarters for these can be quickly provided, better service will be rendered.

Many of the above suggestions may seem unnecessary provisions for remote contingencies, and it is to be desired that occasion should never arise to require their application; but this in no way alters the importance of having such plans carefully worked out in advance.

Fire Protection.—In addition to using fire retardant materials in construction and having an adequate water system for protection in case of fire, a corps of fire fighters should be organized in every town. A part-time organization is all that is necessary in many instances, the members giving services voluntarily, or being paid, as the case demands. Better service will generally

be rendered if the members, or at least a small nucleus for a regular force, are paid. The corps should have a chief or captain, who devotes his entire time to the job. He can profitably spend his time inspecting and testing out fire hydrants, hose, etc., inspecting and calling attention to fire hazards and working out problems for fighting fires in difficult places throughout the town. The fire fighting corps should meet regularly and go through drills, so as to be prepared in advance for emergency.

Provision should also be made in advance for furnishing relief in case of a serious fire. Utensils for cooking and serving food in large quantities should be available. Means should be planed in advance of getting in touch with relief agencies, to obtain food, tents, blankets, etc. All of these details, if prepared in advance, will tend to eliminate confusion at the time of disaster.

School System.—The school system of a company-controlled town need not be dominated by the company. Should funds be low, the company may assist in providing the building, but the system of education should be under the control of the state or county officials. The school system should conform to local requirements. If the public schools of large cities can attempt to serve their diversified commercial and industrial needs, certainly the school system of a company town can effectively do as much. Vocational and manual training should be introduced and emphasized, with a view of developing boys for positions they are to assume later. In an industrial community the school training may well stress industrial, rather than the classical lines. The curricula should be moulded to serve the needs of the ninety per cent. whose future lies with industry, rather than of the ten per cent. who may pursue higher education.

Recreational Activities.—The necessity of promoting healthful recreations for the men, women and children of an isolated town is a very important function of the town management. If the principles of self-support and of participation in control are important for the town, they are even more so for recreational activities. Clubs should be self-managed; the directorate should be elected by the members, who should be charged dues for the privilege of belonging to the club. In a similar way athletics should be organized and controlled democratically. The affairs of such clubs may not run as smoothly as if arbitrarily dictated by a company officer, but in the long run the self-managed institution will win out.

The role of the town manager in regard to recreation should be one of self-effacement; whatever his activities, they should be indirect. If of the right type, he can tactfully see that such activities are promoted and developed by the people themselves, his interest being kept in the background. Once the movement is started, and the interest and enthusiasm of the people aroused, the ideas and suggestions will be abundant.

Town Managership.—The success or failure of company-controlled towns is seriously affected by the type of man selected for the position of town manager. If the town management is separate from the plant management—and it should be, wherever possible—the man selected must be one of force, initiative and with a sense of responsibility. Of course this entire question is modified by the size of the industrial town under consideration. If there is but a small group of houses, the part-time services of an able man would be conducive to better results than would the full-time services of a man of less capacity.

In the case of part-time services, it may mean the closer relationship between town and plant management—unless the services of an outside organization, which has had experience in the management of other towns, can be obtained. Such advisory and directing service is but a step beyond the management of water works, power plants, health service and safety inspection by part-time expert service, and there seems no good reason why complete towns should not be managed in a similar way.

No definite training can be recommended as furnishing the best foundation for success in this field. A number of the professions have supplied capable town managers, among whom might be mentioned school masters, Y. M. C. A. secretaries, lawyers, doctors, engineers, real estate men, etc. Executive ability and human qualities are more important, perhaps, than character of professional training and experience; but all things considered, in large developments that are being built from the ground up, it would appear that, provided he has the other necessary qualifications, one of the engineers who has taken an active part in the town construction, would probably be as suitable for the postion as anyone could be.

SUBURBAN INDUSTRIAL TOWNS

Usually Independent.—Just as isolated industrial towns tend to become company-controlled, so the tendency is for industrial

towns built adjacent or in proximity to established centers to become independent civic units, as far as the company is concerned. This is altogether a desirable condition, the only feature to be guarded against being the intrusion of other large industries in the vicinity, which might tend to create house shortage, providing the new industries failed to promote a housing project—a practice all too seldom pursued.

Methods of Selling Houses.—From the outset suburban towns should be planned and developed with the expectation that the houses will eventually be owned by the people. While the layout of the town should be made under the company's directon, there is no reason why the prospective buyers of the houses should not select, within certain limitations, the types of houses desired. This need not interfere with any zoning regulations or architectural requirements prescribed by the town builders.

In Chapter II, methods of buying and paying for homes by employees were briefly outlined, some of them involving transactions between the company and the purchaser; others making use of a subsidiary realty company; and still others effected through coöperative tenant associations, in which shares of stock, rather than deeds to particular houses, are the instruments of ownership and transfer. All of these systems have the same purpose—to safeguard the interest both of the industrial worker and of the industry. Before any plan is chosen, it should be carefully investigated and adapted to local conditions.

Revenue-Producing Utilities.—Closely connected with the question of sale of houses is the one of providing suitable water, gas and electrical services. All of these services are revenue-producing and should be self-supporting. When the project is developed within reach of public utility companies already organized, contracts should be made with such companies for extension of their services. Alert utility companies are always ready to enlarge their territory, if it promises a suitable and steady income, and while, in some cases, financial assistance may be sought from the industry by the utility companies, this assistance should be required for a temporary period only and, if granted, constitutes a reasonably safe investment.

If utility companies are not available for service, it will be necessary for the promoters of the town to organize utility companies to install the equipment and furnish the service required. Such public utility companies should be organized separately

from the land or housing companies, and the cost of constructing their systems should be kept quite apart from other costs. This procedure is advisable because, if later the town should be incorporated and if it should appear expedient to buy out and operate its public services, the transaction can be arranged with less confusion and with greater equity.

Non-Revenue-Producing Public Services.—Public improvements and services, such as roads, pavements, sewers and public parks are not so easily finances as are the water, gas and electrical services. Much depends upon how easily and rapidly the houses are sold, how soon the streets are dedicated and accepted by the civic unit in which they are situated, and whether or not the town is incorporated as an independent civic unit or is annexed to an existing city. It is difficult to incorporate the town in advance of its completion; and if it is to be annexed to an existing city, the project can not ordinarily wait for municpial machinery to reach the point of building pavements and extending sewers.

The result is that the building company must construct the sewers and pave the streets. The cost of these can be added to the cost of the houses. If the town is incorporated at an early date, the cost of paving and laying sewers in the street intersections may possibly be recovered from the city.

The cost of park improvements is generally more difficult to defray. As a rule, parks will remain in the hands of the realty company promoting the project until a later period, when they may be either donated to the public or sold to the municipality.

Other Public Activities.—The promotion of other public activities, such as school systems, policing, fire protection, all commercial enterprises and welfare activities, in suburban towns can be managed in a manner more or less the same as that previously described under isolated company-controlled towns, the principal difference being that the period of company control is of less duration and the degree of such control less marked.

Just as rapidly as residents in a town become property owners, their interest in civic affairs rises. The town is their town; their savings are staked upon its prosperity; their children must be raised and educated there. A transformation takes place. It is their duty to see that policing is efficient; that the fire protection is adequate. They will quickly become cognizant of their rights as citizens and property holders and, in a short time, the company's share in the control of the town will become less and

less marked, until the final result is an independent, self-governing municipality, similar to other American towns in its hustling energy and its commercial prosperity. But, if the industrial company has done its work well, it will be superior to them in being logically planned and efficiently constructed; in a greater civic solidarity fostered by common industrial interests; and in all the advantages that follow from the application of broad vision and great-hearted intelligence to the building of a community of homes.

A BRIEF SELECTED BIBLIOGRAPHY OF INDUSTRIAL HOUSING AND RELATED ACTIVITIES

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